Teaching Geography

Focus on powerful geography

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Geographical Association

Editor:
Melanie Norman

Email: *m.j.norman@brighton.ac.uk*

Editorial contact:
Elaine Anderson

Email: *eanderson@geography.org.uk*

Writing for *Teaching Geography*

Teaching Geography provides a forum for sharing:

- practical strategies for teaching geography
- critical reflection on geography teaching and learning
- curriculum innovation and change in geography.

If you have a teaching strategy, practical idea, resource to share or particular view on educational practice, we would like to hear from you.

Teaching Geography welcomes articles from PGCE students, NQTs and practicing teachers. If you have an idea but have never submitted an article before and would like some advice, please contact Melanie Norman (*m.j.norman@brighton.ac.uk*), the Editor of *Teaching Geography*, who will be happy to discuss it with you.

We welcome the submission of the following types of article:

1. **Planning and pedagogy** articles critically discuss and illustrate approaches to teaching geography. (1500 words)
2. **The G-Factor** articles (supported by resources online) are based around a practical idea for teaching a lesson or sequence of lessons. (1500 words)
3. **Change and challenge** articles discuss current educational views and how they impact upon geography. (1000–1500 words)
4. **How to...** articles provide practical advice and strategies for geography departments. (750 words)

There is detailed information on preparing articles for publication at *www.geography.org.uk/download/GA_GITGGuide.pdf*

Also from the GA this term...

Teaching Geography readers may also find these articles from *Geography* and *Primary Geography* interesting and relevant. You can download the articles from www.geography.org.uk/shop at a discounted price of £3.99 each (incl. VAT). Subscribers to these journals can download the articles free of charge from the journals page of the GA website as usual.

Getting to grips with the global goals

Elly Lengthorn suggests how the Sustainable Development Goals can allow us to formulate a positive possibility for our pupils' futures.

Real life skills

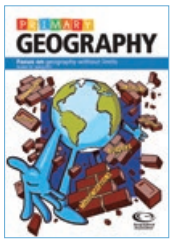
Christopher Kinlan considers the value of outdoor learning in geography for pupils with SEN, and how adaptations to suit the learners will have long-term benefits for the future.

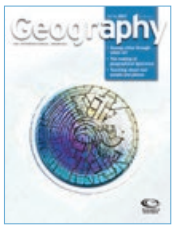
Seeing cities through urban art

Andrew Kirby offers insights into how to use what are now readily-available digital versions of 'urban art' to explore different facets of city life, using paintings as a more nuanced alternative to contemporary film.

Pedagogy and identity in initial teacher education: developing a 'professional compass

Clare Brooks argues why it is important for new teachers to be supported by geography specialists and shows how new geography teachers need to develop their disciplinary perspective on why teaching geography matters.





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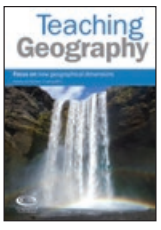

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Geographical Association

Editorial: Powerful Geography

Melanie Norman, Editor

The Editor introduces this issue of Teaching Geography, *'Powerful Geography'.*

The power of the water in our cover photograph is an excellent introduction to this issue of *Teaching Geography* with the theme of 'Powerful Geography'. There are 23 definitions of the word 'power' in my dictionary but in the context of this journal the most fitting is the *'ability to do something'* and the definition of 'powerful' is *'extremely effective or efficient'*. The articles in this first issue of 2017 certainly reflect the ability of geography teachers and students of geography to 'do' geography effectively and efficiently.

Margaret Roberts' article discusses ways in which she believes geographical education is powerful, concluding that we must value students' everyday knowledge, make them aware of the contested nature of the issues geographers study, and foster their skills to assess and evaluate geographical knowledge. Geographical skills, knowledge and understanding have the power to influence students' into adult life, especially when critical thought and active involvement are nurtured in the geography classroom.

Alan Kinder's article develops his belief that geography has the power to inform and inspire young people, to challenge and educate them and ultimately to equip them to live and function as adults in society. Alan says it is imperative that the content of the school geography curriculum addresses this power and makes some suggestions about curriculum content. Aidan Hesslewood's article urges teachers to exercise their skill as professionals to create a powerful geography education for all our students.

Both Rachel Trafford's and Gordon Davis's articles, emphasise the importance of giving geography students the power to develop their own learning. Rachel's fieldwork in Southampton is planned to be more student-led than fieldwork activities undertaken in the past and will lay foundations for the demands of the Independent Investigation at A level. Gordon's 'volunteering' activities have given his students access to active involvement in local projects, one of which resulted in winning a national competition. This success has resulted in an increased uptake of the subject within his school.

The GeoCapabilities article authored by Duncan Hawley, Richard Bustin and Kelly Butler introduces this international project which aims to show how geography education makes an empowering contribution to developing students' ability to participate effectively in a 21st century world. There are more details of this project on the GeoCapabilities website www.geocapabilities.org.

Other articles will help teachers who are developing materials for the new A level specifications. Professor Martin Evans has written a detailed article on carbon cycling in UK peatlands. He notes that the carbon cycling part of the new A level specifications is likely to be less familiar to geography teachers than the water cycling element of the A level common core. Teachers of A level should find his article helpful and informative. Duncan Hawley and John Lyon's article 'Plate update', offers challenges to long-accepted notions about plate tectonics. Their 'refresher' provides readers with subject knowledge about some recent developments in the understanding of this area of study.

A new section inside the front cover of this issue highlights selected articles from the journal content of *Geography* and *Primary Geography*. The Editorial Board thinks the articles listed will provide valuable links for readers of *Teaching Geography*. We hope you will find this a useful addition to the journal.

Reflecting on 2016, thinking geographically is a powerful tool enabling our students to think critically about a range of issues and debates. It will also help them to make decisions in adult life from an informed viewpoint.

I would like to conclude this editorial with some quotations from the GA's manifesto of 2009, *A Different View* (www.geography.org.uk/resources/adifferentview) which further support the power of geography:

> *Geography underpins a lifelong 'conversation' about the earth as the home of humankind.* (p.5)
>
> *An essential educational outcome of learning geography is to be able to apply knowledge and conceptual understanding to new settings: that is, to 'think geographically' about the changing world.* (p.9)
>
> *Geography prepares young people with the knowledge, skills and understanding to make sense of their world and to face the challenges that will shape our societies and environments at the local, national and global scales.* (Dr Rita Gardner, Director, RGS-IBG, p.13)
>
> *What is exciting about geography today is that it is the first curriculum subject in the UK to take seriously the need for critical and creative thinking about the future.* (David Hicks, Professor of Education p.13)

Editor Dr Mel Norman on the South Downs near Beachy Head. **Photo:** Tony Norman.

Margaret Roberts

Geographical education is powerful if…

Margaret discusses the five ways in which she believes geographical education can be powerful.

Accompanying online materials

Introduction

In making a case for a subject-based curriculum, Michael Young (2008; 2015) coined the term 'powerful knowledge': knowledge developed within academic disciplines that most students would not have access to beyond school. Young's ideas have stimulated considerable discussion about the significance of 'powerful knowledge'. I have discussed his ideas elsewhere (Roberts, 2013a; 2014). In this article I want to present my own ideas of ways in which I think geographical education as a whole could be powerful.

1. … it enables students to make connections between their everyday knowledge and school geography

Vygotsky, through his research into children's learning in the 1920s, distinguished between two types of knowledge. He used the terms 'spontaneous' for concepts children developed through experience without instruction and 'scientific' for concepts related to academic disciplines and acquired with the support of a teacher. He found that the development of both types of concept were 'closely connected': children's acquisition of abstract disciplinary concepts grew out of related everyday concepts, and the structures provided by disciplinary concepts enabled children's everyday concepts to develop 'towards conscious and deliberate use' (Vygotsky, 1962).

Vygotsky's ideas have been very influential on education generally and everyday knowledge has been recognised as valuable at all stages of geographical education. Within the context of primary education, Catling and Martin (2011) argue that pupils' everyday knowledge and disciplinary knowledge should both be regarded as powerful. They cite research that shows everyday knowledge is not necessarily naïve and unsystematic, but that it can be rational, coherent and structured. When the two types of powerful knowledge, the everyday and the disciplinary, are brought together in the classroom, children can develop new knowledge and understanding.

At secondary level, everyday knowledge has been an essential part of several Geographical Association (GA) projects. For example, 'Valuing Places' aimed to develop students' understanding of global connectedness by building on their personal geographies of place. The Young People's Geographies Project started with the view that students bring to school valid and important knowledge based on their interests and their needs. Furthermore, the GA identifies 'student experiences' as one of the three key ingredients in the process of 'curriculum making'.

At university level, an undergraduate textbook encourages students to make connections between their everyday experiences and what they are studying. It invites them to:

> *'be aware of the human geographies wrapped up in and represented by the food you eat, the news you read, the films you watch, the music you listen to, the television you gaze at' and 'to 'think about how what you read in books or articles connects or doesn't to your everyday life and why that might be'* (Cloke, Crang and Goodwin, 2005, p. 602).

Everyday knowledge is particularly relevant to the study of geography. First, it is an object of study and a source of data for some academic geographers, who have focused, for example, on young people's geographies, the geography of food and of everyday spaces. Second, students bring to school some knowledge of most themes studied in geography. From the earliest age children get to know their own neighbourhoods, they make journeys and visit shops, parks and relatives. Many visit environments different from their own on day trips or holidays. They encounter, indirectly, a world beyond their direct experience through other people, toys, stories, books, films, television and social media. They begin to develop key geographical concepts of place, space and environment.

Giving students opportunities to connect their everyday knowledge with school geography is powerful because it respects what students already know. It values what they can contribute to thinking about many aspects of geography. It helps them understand new geographical concepts and can enable teachers to correct misunderstandings that could interfere with learning. Our personal geographies develop throughout our lives, so it is valuable to have confidence in using and developing this knowledge.

My own experience of observing lessons suggests that if students' everyday knowledge does not feature in curriculum documents or in lesson plans, then it is given scant attention in the classroom. Time needs to be allocated in lesson plans to enable students to use their rich everyday knowledge and to make connections. When I have observed both students and teachers drawing on their everyday knowledge, it has had a strong impact.

2. … it transforms the ways in which students understand the world

School geography takes students beyond their everyday knowledge. It can introduce students to the diversity of ways in which geographers think about and investigate the world. It can make them aware of the positioned nature of

geographical knowledge. It can introduce them to new concepts and theories.

Urban geography provides good examples of different ways in which geographers study the world and of the positioned nature of geographical knowledge. Massey (2007) studied the interrelationships within and between places and argued that cities could be understood only in the economic, cultural and political global networks within which they are embedded. Dorling (Hennig and Dorling, 2013) used quantitative data to examine the distribution of inequalities in particular cities, e.g. London. Wills (Wills *et al*., 2010) used personal accounts from interviews to focus on migrant workers' experiences of London. Urban geographers who have focused on the personal experience of particular groups (e.g. young people, the elderly, the disabled, etc.) make us aware that people living in cities are not one homogeneous group about which we can make generalisations. Each of these ways of looking at cities is powerful and contributes to our understanding.

Although urban areas are influenced by some common processes, these processes play out differently in different parts of the world. Geographers studying Asian and African cities, e.g. Drakakis Smith (2000), recognise that these have been influenced by very different historical, social and political processes from those in the west. Most knowledge about urban areas has been produced by geographers working in North American or European contexts. Massey has argued that 'our knowledge of the world is always from a certain standpoint. We see it from here rather than from there' (Alan and Massey, 1995, p. 2). Geographical knowledge is positioned, influenced by the lenses through which geographers have viewed the world, framed by the questions to which they give attention.

Many of the concepts that are important in thinking geographically, such as nature, sustainability, globalisation, development, etc. are used with different meanings. Castree (2005) has argued, for example, that geographers have no one understanding of what 'nature' is and that geography 'produces a diversity of knowledges about nature' (p. 244) that are constructed and contestable. In order to deepen their understanding of a concept, students need to encounter different definitions and usages and to discuss their meaning. Similarly, there are different ways of thinking about development and how it is measured. Willis (2014) identifies three main theoretical approaches: modernisation (Rostow's model), Marxist analysis and post-structuralism. They differ from each other in their definitions, their explanatory power and the questions they raise. Students' understanding of development would be limited if they studied only the Rostow model.

Giving students access to geographers' different ways of thinking about the themes and places they study in geography and about different meanings of key geographical concepts can be transformative. This is powerful not only for their thinking and understanding of school geography, but could have an enduring impact on the way they understand the world.

3. … it enables students to be aware of the values dimension of decisions that affect local, national and world geography

The big issues of our time, such as climate change, ensuring future supplies of water, food and energy for the world's growing population, the global gap between rich and poor and global trade imbalances, are more likely to be studied in school in geography than in any other subject. The values dimension of these kinds of issues has long been recognised. Sir Keith Joseph, Secretary of State for Education (1981-86), in relation to issues of pollution and inequality, wrote in 1985:

> *'To my mind, teachers do no service to their pupils if they give them the impression that such problems are easily defined, that the processes involved are well understood so that their occurrence can be straightforwardly explained and that there are always practicable solutions available. Issues such as the ones I have mentioned are matters of legitimate dispute precisely because there are often strong disagreements about diagnoses, goals and strategies'* (Joseph, 1985, p. 294).

Rittel and Webber wrote in 1973:

> *'The kinds of problems that planners deal with, societal problems, are inherently different from the problems that scientists … deal with. Planning problems are inherently wicked'* (p. 160),

They stated that 'wicked problems' had the following characteristics:

- There is no definitive formulation of a wicked problem.
- Every wicked problem is essentially unique.
- Every wicked problem can be considered to be a symptom of another problem.
- Solutions to wicked problems are not true or false but good or bad.
- There is no ultimate test of a solution to a wicked problem.
- There is no opportunity to learn by trial and error.

The kinds of issues studied in school geography, global, national and local, share the characteristics of 'wicked problems'. There are different ways in which issues can be formulated. For example, titles and images on covers of books on climate change draw attention to different aspects of the issue: loss of biodiversity (images of polar bears); loss of human habitats (images of desertification); concerns about energy supply (images of oil refineries); economic interests ('the economics of climate change') or threats to cities (images of flooded cities). Decisions and possible solutions are related to how the issue is perceived.

Issues are controversial because people have different views about how they should be resolved. The stakeholders involved put different emphases on economic, social, environmental, cultural and political values. For example, those against the construction of Hinkley Point nuclear power plant in Somerset emphasised economic considerations related to cost, or environmental arguments related to possible pollution and problems of waste-disposal.

Those in favour emphasised social arguments related to employment, and environmental arguments related to the need for carbon-free energy supplies. There were also political arguments related to the UK's diplomatic relationship with the two countries involved: France and China.

There is an ethical dimension of issues studied in geography. Some situations, e.g. those related to inequalities, raise issues of social justice and might be judged to be absolutely morally right or wrong. Students should have opportunities to discuss the ethical dimensions of the issues they study.

Students, through activities such as public-meeting role-play and decision-making exercises, can develop a better understanding of current issues and a more critical evaluation of arguments used for and against viewpoints. Students can become aware of the ethical dimensions and begin to form their own opinions. They can learn to probe underlying ideological assumptions, e.g. related to market forces or of the role of government. They can think more critically about how issues are presented in the media. They can become aware of who has the power to make decisions. Through studying current issues, they can be made aware that the present geography of the world didn't just happen; it has been shaped by decisions many of which were disputed in the past.

Enabling students to study the values dimension of issues is powerful because it relates to their interests; research has shown that young people are interested in issues that will have an impact on the future of the planet and on their own lives. It is powerful because during their lives outside school they will become aware of many issues with geographical dimensions, will be confronted with arguments for and against a particular solution and will become aware of injustices in the world. School geography has the power to enable students to think more clearly about issues they encounter both now and in future.

- Formulate appropriate geographical questions
- Develop techniques for collecting primary data in the field
- Research secondary evidence from a wide range of sources
- Analyse quantitative and digital data using numerical and statistical skills
- Interpret qualitative data from a range of sources: interviews; textual and visual
- Evaluate the accuracy, reliability and validity of data used as evidence
- Recognise bias and assumptions
- Relate data and findings to existing theoretical understandings
- Identify patterns and relationships
- Form reasoned arguments and qualify them
- Justify conclusions using evidence and reasoned arguments informed by wider theory
- Present findings using cartographic, graphical, communication and literacy skills
- Reflect on the investigation: assess the extent to which questions have been addressed and evaluate the strengths and weaknesses of the methodology, data and conclusions.

Figure 1: Enquiry skills that can be developed in school geography.

4. … students develop the skills needed to deal with the complexity of geographical knowledge and to develop understanding

The skills students need in order to make sense of the world include those particularly associated with geography, such as map reading and GIS, and generic skills related to enquiry (listed in Figure 1) and critical thinking. Although enquiry skills can be developed in other subjects, school geography can make a major contribution to their development because of the range of questions it addresses, its varied sources of information presented in different formats, sometimes from different viewpoints, and its use of different analytical and interpretive techniques.

Everything studied in geography in the classroom and in the field requires the use of some skills. Curriculum documents and lesson plans should identify opportunities for students to develop skills that are relevant to what they are studying so that they can become competent in their use through continual application. If well developed in the classroom and the field, enquiry skills incorporate critical thinking skills which emphasise rigour, questioning and not taking something at face value.

These skills are powerful because they enable students to interrogate, analyse and interpret information. They are powerful because through using them, students can develop critical understanding of how geographical knowledge is constructed and represented. This should enable them to make more sense of representations of the world they encounter not only in school geography but also in their everyday lives.

5. … students take an active part in learning

If geographical education is to be powerful, then it demands a powerful pedagogy. Pedagogy is influenced by what are considered to be the purposes of education and by ideas about learning. I consider that the key purposes of geographical education are to enable students to think geographically and to develop a critical understanding of the world.

My ideas about learning have been influenced by Vygotsky and by those who have researched language and learning in the classroom. I believe that, in order to learn, students need to be actively engaged in the construction of knowledge and that this can be achieved through the use of an enquiry approach and through classroom talk. In an enquiry approach students are, with varying degrees of support from a teacher, involved in considering questions, collecting and using varied sources of data, analysing and interpreting, developing reasoned arguments, reaching conclusions and reflecting on the learning process (Roberts, 2013b).

There has been considerable research on classroom talk and its role in learning. Mercer has described talk as 'the most important tool for guiding the development of understanding

and for jointly constructing knowledge' (Mercer, 2008, p. xi). Barnes (2008) has emphasised the importance of students 'relating new ideas and ways of thinking to their existing understanding' (p. 4) and the value of exploratory talk in helping students 'work on understanding' (p. 4). Alexander, through his research, has developed and advocated the concept of 'dialogic teaching' in 'contrast to the familiar question/answer/feedback routines' typical of classroom talk (Alexander, 2008, p. 26). The characteristics of dialogic teaching are listed in Figure 2.

Dialogic teaching requires a shift in the culture of the classroom. Instead of teacher talk being dominant, students are encouraged to participate in discussion. Instead of the main emphasis on students understanding what is in the teacher's mind, both teachers and students listen to each other carefully and try to understand each other's thinking. This shift is difficult to achieve, particularly in an educational culture that values pace and frequent changes of activities. Socratic questions, used by both teachers and students, can provide a useful framework for promoting dialogic talk and can help students think geographically. Socratic questions are categorized according to the type of thinking they encourage (Figure 3).

If geographical education is to be powerful then the culture of the classroom needs to value an inquisitive approach to learning and student involvement in purposeful activities, discussion and critical questioning.

Dialogic talk is:

- **collective** – participants address learning tasks together, distinct from 'question-answer-tell'
- **reciprocal** – participants listen to each other and consider alternative viewpoints
- **supportive** – students speak freely, without fear of embarrassment over wrong answers, and help each other to reach common understandings
- **cumulative** – participants build on answers… and chain them into coherent lines of thinking and understanding
- **purposeful** – although open and dialogic, talk is also planned and structured with specific learning goals in view.

Figure 2: The characteristics of classroom talk in dialogic teaching. **Source:** Alexander, 2008.

Socratic questions:

- seek clarification, e.g. *Is your main point …? Could you give me an example …?*
- probe assumptions, e.g. *Does your reasoning depend on the idea that …?*
- probe reasons and evidence, e.g. *What are your reasons for saying …? Are these reasons a good enough explanation?*
- consider viewpoints and perspectives, e.g. *What different ways are there of looking at it? Who benefits from this? Who loses?*
- probe implications and consequences, e.g. *What effect would … have?*
- ask questions about the question, e.g. *Why is this issue important? How can we find out …?*

Figure 3: Categories of Socratic questions and some examples.

Conclusion

I have argued that geographical education is powerful if it values students' everyday knowledge, enables them to see the world in different ways, makes them aware of the value-laden nature of issues studied in geography and equips them with the skills to make sense of geographical knowledge. It is powerful if the transformative effects of geographical education on students' thinking endure beyond school into adult life.

Essentially, however, all this depends on a powerful pedagogy, which in my view should give a prominent place in the culture of the classroom to promoting thinking and critical understanding and to promoting students' active involvement, through investigative approaches and classroom talk, in the construction of geographical knowledge and understanding.

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Margaret Roberts was President of the Geographical Association from 2008-09 and is a former Editor of *Teaching Geography*.

Email: *margaret.roberts20@btinternet.com*

Alan Kinder

The power of geography

Alan focuses on the power of inspirational curriculum content to prepare students for their future lives.

Accompanying online materials

Introduction and approach

This article comes largely from a personal rather than a research perspective, since the ideas within it are derived from the many years I have spent teaching geography to young people, working with geography teachers on curriculum development and participating in debates over National Curriculum and qualification frameworks. The immediate personal context is one where, as Chief Executive of the Geographical Association (GA), I am periodically invited to explain to non-geographers, 'what's the point of learning geography?'

But there is also a national context. I have argued previously that the National Curriculum for geography affords considerable freedom over detailed content selection (Kinder, 2013). As more schools convert to academies, fewer are subject to the statutory Programmes of Study in any case, and so one could argue that the majority of key stage 3 geography teachers now have greater curriculum freedom than at any time since the introduction of the first National Curriculum in 1991. It therefore seems a good time to revisit the question, 'what geography should we teach?'

This question has of course been subject to close attention over the years (e.g. Kinder and Lambert, 2011). Nor is this process unique to the UK: the nature and content of the geography curriculum has come under scrutiny in many other countries across the world (see, for example, the 'Wikigeo' (IGU, n.d.)). In this article, I make no attempt to establish a theoretical framework but instead wish to offer some foundational content elements for the 11–14 curriculum – what we might regard as its 'geological underpinnings'. My approach is to start with a metaphorical blank page and to ask, 'what geographical themes should be taught at key stage 3, i.e. the final stage of statutory-for-all geography education?' By doing so, I hope to focus on the power of geography to inform and inspire young people, to challenge and educate them and ultimately to equip them to live and function as adults in society. My focus is on curriculum *content*, rather than the outcomes arising from a high-quality geographical education, such as spatial and relational thinking (GA, 2012), or the development of investigative skills though fieldwork or enquiry (Roberts, 2014).

Physical processes and landscapes

As the GA's Manifesto for geography (GA, 2009) makes clear, part of the power of geography is to both 'satisfy and nourish' the connection with and curiosity about the world experienced by every human being. This creates a strong argument, I think, for the curriculum to take young people *beyond* themselves and their everyday experiences by studying the extraordinary physical variety of Earth's surface. There is (or can be) a visceral feel to this geography: exploration of the sheer scale, diversity and majesty of Earth's landscapes and natural environments; encounters with the extremities of climate, natural history and topography. 'Awe and wonder' are not the only responses to anticipate here: the scale of the world, the idea of deep time or the indiscriminate violence of some natural phenomena can make humans feel vulnerable and inconsequential. At the same time, they stir curiosity in young minds, which may begin to wonder, for example, how an unearthly landscape was formed (Figure 1). This reminds us that geography at every level has the potential for both explanatory and descriptive power, meaning that students in this key stage need to be taught the processes which create landscapes in order to better understand the world in which they live.

Figure 1: The unearthly landscape of hoodoos in Bryce Canyon National Park, Utah.
Photo: © Alan Green

Figure 2: The extraordinary ability of humans to adapt to extreme environments. Touareg in Ténéré Desert, Niger. **Photo:** © Alessandro Vannucci

Societies and cultures worldwide

Of equal importance is for students to be given opportunities to appreciate the range and variety of human societies across the world. This is geography as 'the study of the Earth as home to humankind' (Johnston, 1985). It is true that the human population and occupation of the Earth causes significant challenges, both for us and for the natural environment, and that our numbers and the way some of us live our lives exerts pressure on natural resources and systems. But before we confront young people with these challenges we should introduce them to the quite extraordinary ability of humans as a species to adapt to environments right across the planet (Figure 2): this is after all the reason our numbers have multiplied. Which of us is not intrigued by the people living in the wettest, coldest, hottest and highest places of the world? Urbanisation is equally significant and can be equally exciting to students in this age range. Cities are one of humankind's most enduring accomplishments, and despite the historic and contemporary concerns they create around issues such as migration, transportation and environmental impact, they remain remarkably successful forms of social, political and economic organisation. Only geography can help us understand a seeming contradiction: just as modern technology allows us to communicate across distance more easily than ever, more and more of us choose to gather together in cities.

Human welfare, development and globalisation

If studying the human occupation of the Earth is inherently geographical, then so too is investigating variations in human welfare. Regarding human development over time, there are some noteworthy achievements to be celebrated with key stage 3 students; as well, of course, as some very significant challenges. Chief amongst these is global inequality, and the fact that 1 % of the world's richest individuals own the majority of its wealth is a striking illustration of the moral, political, social and economic problems it poses (Figure 3). Geography's insight is to show us the ways in which people produce and consume resources, lend and invest money, arrange terms of trade, colonise and decolonise and so on have the most profound effect on patterns of wealth and inequality. Geography therefore helps young people begin to make sense of the range of processes we now call globalisation. Geography's power is, I think, that the subject does not treat globalisation as an inevitable 'force of nature', but as myriad decisions enacted through human agency; connected to political and economic power, and therefore uneven and asymmetrical. Some examination of globalisation and global development must surely, therefore, form part of 11–14 study.

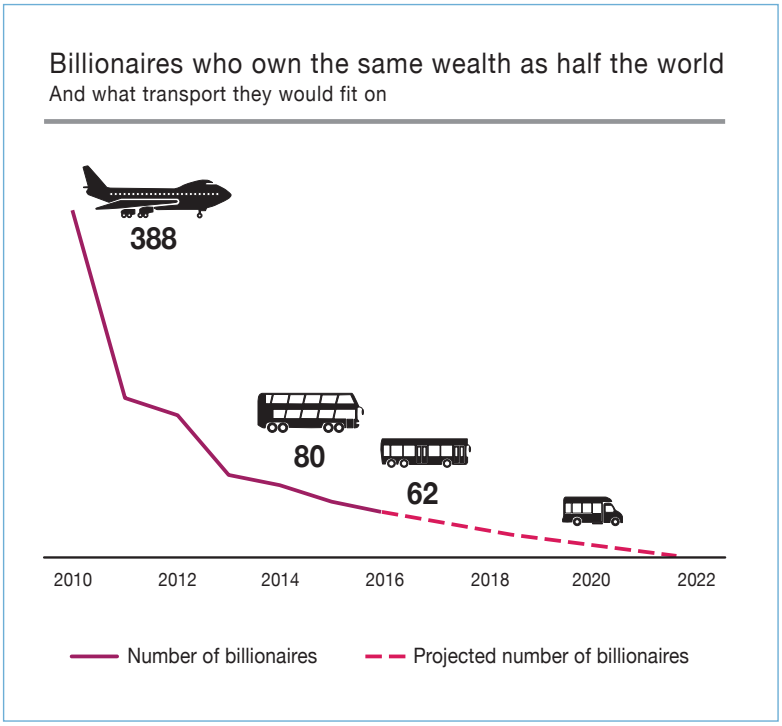

Figure 3: The number of people who, as individuals, own the same wealth as half the world combined. **Source:** Oxfam, 2016.

Identity

Returning to the GA's Manifesto (*ibid.*), we are reminded that geography also has power at the personal scale, because it helps young people investigate their own identity (and often multiple identities). Geography helps us ask, 'who am I and what is my place in the world?' through:

- careful study of our locality, which helps reveal a young person's sense of place and community (see, for example, *www.geography.org.uk/projects/makingmyplaceintheworld*);
- exploring ideas such as diversity, difference and similarity by studying both local *and* distant places, our own *and* other countries;
- understanding the complexity of places – their uniqueness, but also the way they are shaped through external connections, which helps deconstruct stereotypes and avoid the danger of the 'single story' (Adichie, 2009);
- taking students from naming and locating countries, to understanding how places, territories and borders help shape our culture, identity and sense of self (Rawling, 2016; Massey, 2006) (Figure 4).

Human-environmental interaction

Perhaps geography's greatest educational contribution to key stage 3 is the way it brings physical and human realms together. Writing about geography's place in the world, an eminent geographer claimed that the 'great challenges of the 21st century are geographical in their formulation, analysis and consequence, and they transcend the physical/social divide' (Dorling, 2016). The growth of academic 'nexus studies' as an approach to understanding food, water and energy security, climate change and many other contemporary issues seems to back this assertion.

Alan Kinder is Chief Executive of the Geographical Association.

Email: *akinder@geography.org.uk*

Figure 4: A small fence separates densely-populated Tijuana, Mexico, from the relatively sparse outskirts of San Diego, USA. Hundreds of thousands of people try to cross the border from Mexico into the United States every year. **Photo:** © Sgt. 1st Class Gordon Hyde (CC BY-SA 3.0).

I infer from this that the 11–14 curriculum should include study of human-environmental interactions, and that regular reference to the environmental, social, economic and political dimensions of study – with analysis of the way these dimensions are interdependent – can have a powerful influence on students' future habits of mind.

This brings us to perhaps the most powerful and profound message for inclusion in our key stage 3 curriculum – the Anthropocene. Earth scientists now talk of the 'game changing' impact humans are having on multiple Earth surface systems (chemical, sedimentary, biological, etc.). In January 2016, the respected journal *Science* (2016) announced that the Earth has endured changes sufficient to leave a global stratigraphic signature distinct from that of the Holocene, meaning that we have entered a new geological epoch in which the actions of humans will be recorded in the very fabric of the surface of the Earth. What more geographical topic is worthy of study for young people today?

Conclusion

I finish this somewhat subjective outlining of the geography curriculum by simply asking: what's in yours?

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Seizing the opportunity for a new era of fieldwork

Rachel Trafford

Rachel describes how her department has taken the opportunity of new syllabuses to incorporate geospatial technology into a student-led GCSE field trip.

Despite the obvious burden of planning, new specifications at GCSE and A level present us with an opportunity to review, refresh and redevelop our fieldwork programme across the curriculum. At Wellington College we have moved to Edexcel B at GCSE and OCR at A level. While we can adapt some of our existing fieldwork to fit the requirements of the new specifications, we are also developing some new ideas. Here, I focus on one of these, discussing:

- how to meet some of the requirements of the new Edexcel B specification (which hopefully could be applied elsewhere) such as a case study of a major UK city, its structure, changes and challenges; and investigative skills: variation in quality of life and environmental quality
- how to bring a more 21st-century feel to fieldwork that incorporates the use of geospatial technology (and moves away from the era of the clipboard!)
- how to achieve a genuine sense of student-led enquiry (as far away from the dreaded Controlled Assessment-style as possible!), in part to prepare students for the more demanding Independent Investigation at A level.

Selecting a location and preparing for a new field trip

We decided that Southampton would be the most suitable location for the case study of 'a major UK city with a population of more than 200,000 people' for several reasons: it is conveniently located around an hour from Wellington College, it has a current (and growing) population of around 250,000 people, it is a manageable size (students will be able to walk transects between the city centre and suburbs in a few hours, for example), it is less complex than other possible locations, for example London, and it has a rich industrial heritage, so has undergone significant change as a result of de-industrialisation and subsequent regeneration. The first Southampton field trip is planned for our 4th form (year 10) cohort of 130 students in May 2017.

Planning for the Southampton fieldwork day

Provisionally, our aims are to:

1. achieve a more open-ended, enquiry-based feel to fieldwork, in line with our department philosophy, including effective use of geospatial technology;
2. expose students to the required urban fieldwork skills for the Edexcel B GCSE specification *and* to support an in-depth investigation of Southampton as the 'major UK city' case study;
3. provide effective preparation for the A level Independent Investigation in two years' time, by engendering a more observational, questioning, naturally investigative approach to fieldwork in students.

The aims that we would communicate to students might be to practise and develop their observational and fieldwork skills, understand how and why the city changes across space and time, and to familiarise themselves with the character of different areas, and collect quantitative data to assess how environmental quality varies across the city.

Structure of the field trip

The day will be split into two parts for each group of students, as outlined in Figure 1. The tasks are designed to be relatively open-ended, question-driven and problem-solving in style, and to encourage students to observe closely the characteristics of the environment around them. The transects in particular will build on preparatory work during which students will form an impression of the areas they will visit (using census data, for example): during the fieldwork they will have to assess how far the reality conforms to their expectations. Hence the enquiry question for that part of the day is the same for each group, albeit with different transects. The open-ended discovery task is partly an experiment but also offers an opportunity for differentiation: higher ability students are most likely to be able to cope with the relative lack of direction and to rise to the challenge of developing their enquiry formulation skills. We anticipate that all groups working on the city centre tasks may require some support, and envisage a mentoring, drop-in style to help them to gain maximum value from their time in the field.

Since the city of Southampton forms an in-depth case study rather than merely a location in which to develop fieldwork skills, the logistics are important. Every class as a whole will need to complete all of the city centre tasks and each of the transects, dividing the work between five groups of students, so that information-sharing can be sufficiently comprehensive to enable them to build up a full picture of the whole city rather than just the parts they visited in their groups.

The format for their 'data collection' will comprise photographs (perhaps including annotations using an app like Skitch) and/or video footage for the city centre task (which they will later compile into a presentational format following the field trip). It is our expectation that at that stage, for both the morning and afternoon tasks' follow up, they will also include secondary data (such as census data).

Part of the day	Possible enquiry question	Suggested additional guidance for students	Expected location(s)
Morning: city centre	If you were to draw a line around Southampton's central business district (CBD), where would you draw it and why?	What would be inside the line and why? What would be outside the line and why? What fieldwork could you do, i.e. what data you could collect, to help?	City centre and inner city
	How far is gentrification defining the character of the Oxford Street area?	How would you define 'character'? What evidence is there of gentrification/other processes? What fieldwork could you do, i.e. what data you could collect, to help?	Oxford Street area
	How far does evidence suggest that the development at West Quay is shifting Southampton's peak land value intersection? (PLVI)	How might the location of the PLVI have changed over time? To what extent is there evidence of that change occurring? What fieldwork could you do, i.e. what data could you collect, to help?	West Quay/ city centre
	To what extent is city centre regeneration in Southampton capitalising on its heritage to achieve its aims?	What evidence can you see of heritage influencing regeneration? What else is playing a role? What fieldwork could you do, i.e. what data could you collect, to help?	City centre
	Open-ended discovery: carry out some fieldwork of your choice in Southampton's city centre	Be creative: the weirder and wackier the better! Make sure you have a clear aim and methodology: make it purposeful Ensure there is a geographical basis for whatever you investigate	Various
Afternoon: transects	How does your experience compare to your expectations?	Review your prior expectations regularly Make careful observations of: • land use, building age and density • evidence of culture, ethnicity, age structure • environmental quality and provision of services • change over time (social and economic; growth and decline) To what extent does the evidence support your expectations? To what extent does the evidence contradict your expectations? How would you characterise each area? To what extent do the areas change as you move through the city? What questions do your observations raise? What would you like to know more about? What is particularly interesting to a geographer?	**E:** Derby Road/ Portswood Road **N:** Eastern side of the Common **N:** Western side of the Common **W:** North-eastern side of the A3057 **W:** South-western side of the A3057

Figure 1: Summary of the proposed fieldwork day in Southampton.

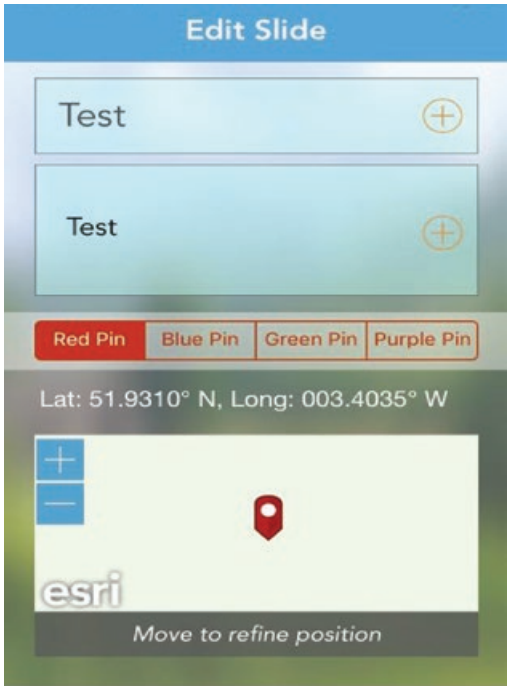
The transect data will be collected using the Snap2Map app which enables students to create a Map Tour StoryMap via creation of individual slides (geolocated photographs, with the opportunity to add description either in the field or at a later point: see Figure 2). Those slides are then published at the press of a button into a StoryMap (Figure 3), which can be re-edited and shared via a weblink.

Using GIS to map environmental quality

One common thread running through the day is that students will, at frequent intervals, collect and record data on environmental quality, with the aim of collectively building up a picture of variation across the city (and perhaps over time). They will use an app called Collector for ArcGIS (available free for both iOS and Android devices) that will enable individuals across the year group – via their own ArcGIS Online (AGOL) account – to contribute to a collaborative map of environmental quality, most likely using a Likert-style scale, which they can design to take into account several dimensions of environmental quality. At each data point they can also upload a photograph. Figure 4 shows the raw output of such a collaborative map; that map could then be analysed using AGOL features such as hotspot analysis. The beauty of using Collector for ArcGIS is that each entry of geolocated data is displayed instantaneously on the collaborative map, so any students who are using a 3G or 4G connection can see theirs and others' data upload immediately (though they can also wait until they are back on wifi and then sync it). Teachers need to do a small amount of preparation to collect data using the Collector app, such as setting up the map for students to download to their device, but it is simple, easy and quick. One preparatory task for students is to decide collectively how best to measure environmental quality.

These approaches to data collection and presentation have several aims, which are to:

- reinforce the importance of careful and thoughtful observation
- offer a format which interests young geographers with a geospatial element that makes use of 21st-century technology to enhance learning
- expose students to possible alternative formats to a written fieldwork report (such as StoryMaps, which we understand will be permitted for Independent Investigations)
- engender an investigative, question-formulating approach to fieldwork which helps to prepare students effectively for the future.



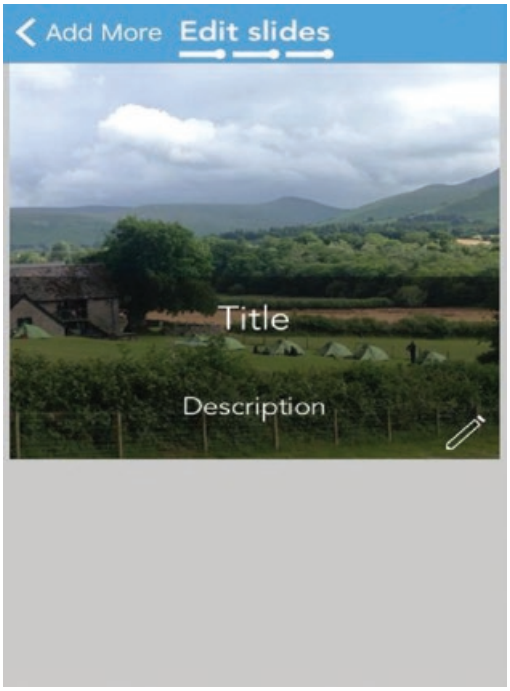


Figure 2: Screenshots from Snap2Map app at the point of slide creation.

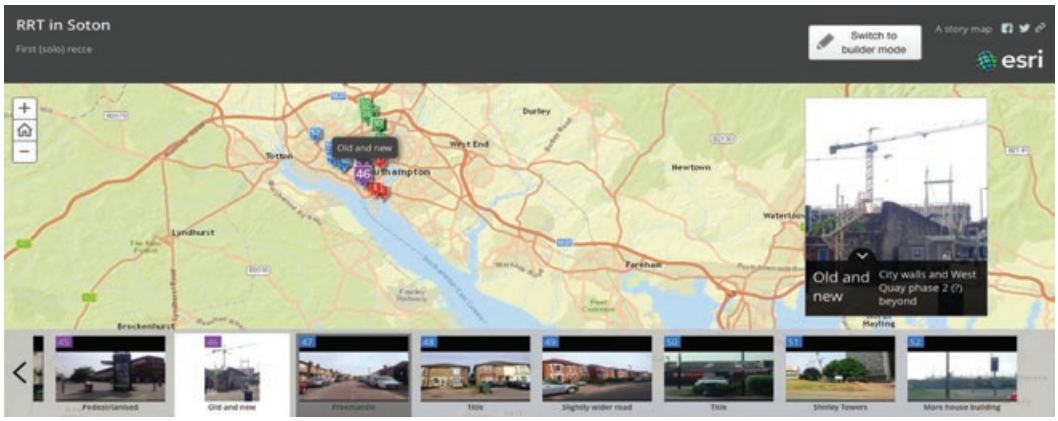


Figure 3: Example of a published Map Tour StoryMap, created using the Snap2Map app.

Positioning the field trip within a whole unit of work

Some work will need to be completed in preparation for the field trip in its current planned format – for instance, students must write the criteria they will use to assess environmental quality, and undertake research to formulate their perceptions of the different areas they will visit. Our expectation is that these will be incorporated into an introductory study of Southampton, which may include some of the following (perhaps presented in the form of a Story Map):

- Southampton's site and situation
- its urban structure
- variations in the character of different areas across the city
- change over time, such as urban decline, growth and regeneration.

Land use maps, OS maps, satellite images and GIS will be central to this unit of work, as well as secondary sources of information such as census data.

Figure 4: A collaborative map of environmental quality data, compiled using Collector for ArcGIS, shown in its raw form during/immediately after data collection.

Conclusions

The overriding themes of the Southampton unit of work, including fieldwork, are clear and interest budding young geographers: change over time and space and how this affects the character of different parts of a city; the role of heritage in regeneration; the resulting juxtaposition of old and new as Southampton embraces it past to define the nature of its future. At the time of writing our plans are at a relatively early stage; hopefully by the time you read this they will be ready for implementation. As a department, we are hugely excited about a more student-led approach to fieldwork and the opportunity to lay valuable foundations for the A level Independent Investigation.

Rachel Trafford is Head of Geography at Wellington College, Berkshire.

Email: *RRT@wellingtoncollege.org.uk*

Gordon Davis

Volunteering: raising the profile of geography?

Gordon reports on a volunteering approach that his department adopted as a catalyst to increase recruitment to GCSE.

Nationally, geography is currently enjoying a period of improved uptake at GCSE and A level. However, this success has not been reflected at St Paul's Academy, Greenwich; a specialist school for sport and enterprise. Most of our students are from minority ethnic groups, and for many English is an additional language. About a quarter of students are disabled or have special educational needs. We have struggled to recruit more than 50% of year 8 students for geography, and the last two years have seen a fall to 32%. This raised the question 'How can the geography department make the subject more relevant and attractive, to reflect its success nationally?' I decided to elicit the views of year 8 and year 11 students about how geography could be made a more attractive option at GCSE. The methodology I used was a questionnaire and semi-structured interviews.

What do students like about geography?

The dominant theme emerging from their responses was the popularity of outdoor learning:

- 'Try to take out the class to more sites and case studies to see the real-life application of geographical techniques in the world' (year 11).
- 'KS3 geography could be improved by them making it more exciting with classroom activities because the lessons are quite BORING!!!' (year 8).

During interviews, students also expressed the wish to do more group work:

- 'I would do group work, pairing students up with who they would not usually work with. I would do more field trips. People will experience the outer world and not just textbook work because I feel that people need to actually see it to believe it sometimes' (Interviewee C, year 11)

Departmental response

Taking into account all the students' recommendations – more outdoor learning, group-based work, engagement with career pathways and ICT tasks – the geography department has succeeded in both creating outdoor learning experiences and revitalising the key stage 3 curriculum. Seeking to engage students in what Hargreaves (2008) called 'theory-in-action of educational change', we set up focus groups of year 8 and 11 students, and working with volunteer teachers, we have created a volunteering initiative that allows the students to experience their study topics in real life.

The volunteering projects

Our volunteer programme originally involved working with local charities on schemes that reflected geography topics, for example the biodiversity of river habitats; other activities have developed as a result of student feedback. The Thames 21 Project, located on the River Cray, clears litter from the river (Figure 1) and drainage tunnels, plants reeds and maintains marshland. The Woodlands Farm project offers students the opportunity to work with animals, to bramble-bash and to collect hay. At Stave Hill Ecological Park students help to conserve rare species through planting, hedge-laying and creating fresh-water marshlands. Volunteering experiences are rotated on a three-month basis to ensure a diverse range of activities. The programme has led to over 60 students from years 8–11 doing voluntary work in their local communities.

The programme emphasises a holistic approach, which develops cognitive processes and understanding, leading to effective learning. Geography students and teachers have both benefitted from the renewed subject pedagogy and experiences outside the classroom.

Figure 1: A river litter sweep with year 8.
Photo: © Gordon Davis.

Figure 2: 'Where's your next geography classroom?'. **Photo:** © Gordon Davis.

Outcomes

The use of Thames 21 and River Cray volunteering as a case study of local river management in mock exams testifies to the success of our 'geography in action'. Students develop a range of skills including team building, collaboration and independent learning, which are easily transferable to the classroom environment

Our year 7 'Maps and Mapping' scheme of work, formerly predominantly classroom-based, is now connected to outdoor experiences, such as the River Cray Ordnance Survey map challenge or geocaching. Our revised curriculum includes trips to the Earthquake Centre at the Natural History Museum and fieldwork in Dorset.

Future plans

We are adopting the slogan 'Where's your next geographical classroom?' which will raise the subject's profile in both the school and the local community. We have used social media including a blog, YouTube, and the school Twitter account to publicise both the slogan and the students' successes; one such accolade has been year 10 winning a Wide Horizons national competition for a £10,000 trip to Wales. This can be seen via the geography blog at *http://mrgdavis.blogspot.co.uk*

Conclusion

At the time of writing, the uptake of GCSE has been boosted by 14% for the coming academic year; but of course many other benefits accrue from this initiative. Voluntary work makes students stand out from other candidates when applying for admission to university or college, or for apprenticeships. It also supports school-run award schemes, such as the Jack Petchey Award, and external initiatives such as the Duke of Edinburgh Award. Students' working together across different year groups enhances community cohesion in the school. Most importantly, from the department's point of view, volunteering improves students' geographical understanding: practical experience of developing marginal habitats in a river to increase biodiversity, or grasping the concept of migratory corridors through hedge-laying, gives them a depth and breadth of understanding unachievable through classroom lessons. And the process of embedding these attributes develops what Malone (2008) describes as 'the whole young person'.

This will move beyond Kitchen's (2013) description of a curriculum that is 'tokenistic' to one that contains the creativity and intellectual appeal needed to encourage our young people to study geography in the 21st century.

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Gordon Davis is Subject Lead for Geography at St Paul's Academy, Greenwich.

Email: *Gordon.davis@stpauls.greenwich.sch.uk*

Richard Bustin, Kelly Butler and Duncan Hawley

GeoCapabilities: teachers as curriculum leaders

Three partners in the GeoCapabilities project outline its scope, give examples of its application to curriculum thinking and describe how it can enhance the power of curriculum artefacts.

Accompanying online materials

Introduction

Duncan Hawley

The initial impetus for the GeoCapabilities project was to find a way to help geography teachers think more powerfully about the aims and purposes of what they teach and how it makes a distinctive contribution to developing students' capacities to participate effectively in a 21st century world (Lambert and Morgan, 2010). The project has been developing approaches that can help geography teachers re-assess the roles of geography as a subject, and of geographical knowledge in their classroom teaching, to help teachers become curriculum makers and curriculum leaders.

The project has partners from the USA, Finland, Greece and the UK and a growing pool of 'associate partners' from all over the world. The main output of the project is a framework of practicable ideas, designed to develop curriculum leadership in geography teachers, that can be explored through four flexible online training modules (Figure 1). These can be undertaken by individual teachers, form part of in-school CPD training or be integrated into teacher training. The contributions that follow exemplify how two of the project's school partners have interpreted and developed two of the core ideas of the GeoCapabilities approach and demonstrate their direct classroom relevance.

The GeoCapabilities approach chimes with a number of the Geographical Association's (GA) key principles, e.g. its mission 'to further geographical knowledge and understanding through education' and its strategic aim to 'demonstrate the value of geographical education more widely' and to 'meet teachers' professional and educational needs'; it also accords with the GA's manifesto *A Different View* (2009). It will be no surprise, therefore, to learn that the GA has been a leading partner in the project.

- Module 1: Capabilities and powerful knowledge
- Module 2: Curriculum making by teachers
- Module 3: Video case studies
- Module 4: Curriculum leadership and advocacy

Figure 1: GeoCapabilities modules. **Source:** *www.geocapabilities.org* and *www.geography.org.uk/projects/geo-capabilities*

Where's the geography? A capability approach to curriculum thinking

Richard Bustin

As teachers of geography we want to ensure that geographical knowledge is at the heart of our lessons; yet in practice this can be a challenge, given the ubiquity of thinking skills and child-centred approaches pervading education. In this article I offer a practical method of curriculum planning using the 'capability approach' which ensures that subject knowledge is included. The ideas here are based on original doctoral research as well as the GeoCapabilities project.

Margaret Roberts (2010) drew attention to the lack of knowledge content in geography:

> *I have become particularly concerned about the extent to which lesson plans, lessons and debriefing give more attention to general aspects of lessons than to the geography being taught and learned* (p. 112).

Only three of 33 Teachers' Standards (DfE, 2013) required for qualified teacher status actually refer to subject knowledge, and inspectors can judge geography lessons 'outstanding' with only a cursory mention of the knowledge content. An increasing number of non-specialists are teaching geography classes, and there are fewer subject-specific university-based courses for trainee geography teachers (Tapsfield, 2016). If teachers do not have a thorough understanding of geography, it seriously erodes their ability to introduce the subject and engage students with it. However, a curriculum framework such as the capability approach can help teachers plan a strong geographical content into their lessons.

The capability approach

The 'capability approach' derives initially from studies of human development by Amartya Sen (1980; 1999), which were taken up by Martha Nussbaum (2000). Levels of development are understood not in terms of measurable data, such as literacy rates or income, but as an articulation of individual freedoms. These freedoms are the 'capabilities' that people and societies have to live life in the ways they choose. Some educationalists, such as Walker (2006), argue that success in education should be measured by the 'capability' it affords young people to think in certain ways and to make life choices, rather than primarily by the grades achieved in examinations.

The GeoCapabilities project has grappled with the contribution geography makes to these capabilities. In essence the project probed the question of how 'powerful *disciplinary* knowledge' (a term developed from Young, 2008) can contribute to the thinking and empowerment of an educated person in the 21st century. Some typical ways in which geography lessons can develop powerful disciplinary knowledge are shown in Figure 2.

Powerful knowledge of geography	How it can be developed
Deep descriptive 'world knowledge'.	Locating and mapping places, developing a 'sense of place', finding data on people and places (which can be primary data collected as part of field work)
Theoretically informed relational understanding of people and places in the world.	Processes: physical processes that give rise to landforms and landscapes (such as erosion) and human processes (such as migration, globalisation). This has also been articulated as 'thinking geographically' by Jackson (2006).
A propensity and disposition to think about alternative social, economic and environmental futures.	Sustainability as a core concept, thinking about 'futures' (social, economic, political, physical) and investigating personal responses to phenomena.

Figure 2: The powerful knowledge of geography, and examples of how teachers can develop it in class.

Figure 3: Results of an initial curriculum planning activity for lessons on Russia.

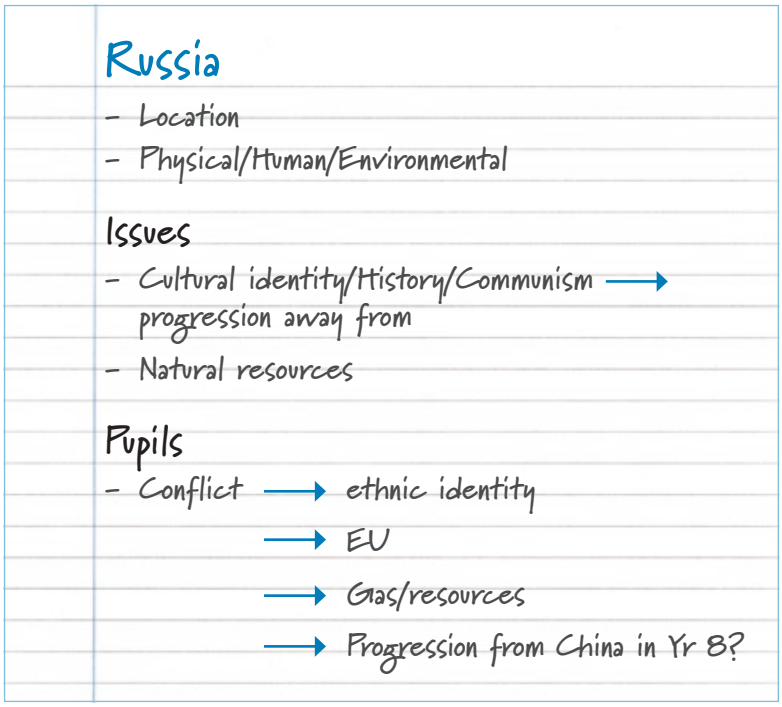
The GeoCapability approach to curriculum thinking

I ran a workshop with a small group of teachers to develop an approach that geography departments might adapt to help plan aspects of the curriculum to ensure that lessons included powerful geographical knowledge. I asked teachers to work together to devise an outline plan for a 10-lesson sequence (roughly half a term) for a class of high-ability year 9 students on the topic of Russia, which was not yet part of their school curriculum. They were not allowed internet access, nor to see how this topic had been tackled in textbooks. I wanted them to use their geographical expertise to decide what were the important aspects of Russia to teach. Figure 3 shows the results of their initial discussions.

Given the potential vastness of 'the geography of Russia', it took a lot of discussion for the teachers to formulate their plan. They opted for an issues-based course: a broad overview, then a focus on geopolitics and Russia's relationship with the rest of the world. Their decision was based on their own understanding of the significance of geography as a subject and what they felt young people would benefit from knowing. Different teams of geography teachers working in different schools might well develop a different set of content around the same topic. Other approaches could focus on physical processes in different regions, or the impacts of climate change on the country.

To help teachers to structure their discussions and ensure they have planned rigorous 'powerful' geography into their lessons, I devised a GeoCapability 'framework' (available to download). Expressions of the powerful knowledge of geography are given at the head of each of the columns. Teachers can take their initial ideas for a lesson sequence and map them into the appropriate place on the framework. Thus the framework does not generate ideas, but acts as a checklist for rigorous knowledge. Existing departmental schemes of work can be placed in the framework to check the knowledge content. In the workshop, teachers used the framework to map out the knowledge content of the Russia sequence they had designed (Figure.4).

When the sequence is placed in the framework the geographical content is clear, so from these ideas a full scheme of work can be created that is sure to contain 'geography', along with an understanding of what is significant about it.



The capability approach: GeoCapability framework		
Deep descriptive 'world knowledge'	*Theoretically informed relational understanding of people and places in the world*	*Propensity and disposition to think about alternative social, economic and environmental futures*
Place and space	**Human and physical processes**	**Choices about how to live**
Russia – where/extent, cities, physical landscape	Why cities are where?	
Natural resources	Why oil/gas/coal?	Extraction Supply/demand Sustainability Conflict of use
Contemporary conflicts – Ukraine – location EU/Russia divide	Why the conflict – cultural identity? Age Resources?	Future solutions to conflict
World stage – Development Russia/BRICs	Classification/ globalisation rate/human rights/HDI/trade	Sustainability

Figure 4: The completed GeoCapability framework.

Lessons can then be devised to help students engage with the content. The content of individual lessons can also be assessed for geographical knowledge by using the framework.

Conclusions

Understanding the powerful disciplinary knowledge of geography can help teachers to ensure lessons contain rigorous knowledge content. The capability approach provides a rationale for that knowledge, positioning it in a broader set of ideas which link a teacher's curriculum aims to student-focussed curricular outcomes.

This thinking is significant for teachers in a number of ways. Firstly, it directs attention away from seeing the subject simply as a means of achieving examination results, and focuses instead on the intrinsic educational value of geography. In turn, this supports the existence of a subject-based curriculum, under threat in contemporary discussions such as those advocating a skills-based curriculum (Reiss and White, 2013). Articulating the existence of GeoCapabilities, as part of a broader framework of knowledge-based capability, can help teachers and school leaders see the significance of geography as a subject, and respects the need for subject specialist teachers in the classroom and for rigorous subject-led initial teacher training courses.

GeoCapabilities in the classroom: using curriculum artefacts to enhance geography teaching

Kelly Butler

Geography is a subject that is material as well as conceptual, so it is important for teachers to have access to high-quality, well considered resources to enable students to engage with new and developing geographical knowledge. In this article I describe how understanding curriculum artefacts can enhance existing resources and geography teaching. The ideas are based on my Masters research, subsequently developed in the GeoCapabilities project. The GA has written extensively on curriculum making and this information is available on the GA website.

How are curriculum artefacts relevant?

A geography curriculum artefact allows teachers greater access to geographical knowledge by unpacking and re-packing layers of meaning. In curriculum making an artefact can take any form: a video clip, photograph, a poem, a song, a first-hand account, a map, and so on. An artefact extends students' existing knowledge and challenges their minds to understand geographical theoretical content and concepts. An artefact is a vehicle of powerful knowledge for a teacher to identify and unpack. This makes it different from a teaching resource used without subject-specific purpose and guidance. Learning is constructed through skilled, subject-disciplined interpretation, and this is where the special significance attached to the artefact by the teacher, combined with their classroom skill, enables students to develop the capability to think geographically.

The idea of curriculum making, articulated in the GA's manifesto *A Different View* (GA, 2009), was developed in the GA's Action Plan for Geography, 2006–11. The GeoCapabilities version of the GA's curriculum-making model (Figure 5) retains the core idea of a good curriculum maker balancing three sources of 'energy' in the classroom. The GeoCapabilities approach emphasises the subject discipline and encourages teachers to ask questions about knowledge, pedagogy and learning. Consequently, the *teacher* will apply a *geographical* perspective to the selected artefact. The *teacher* thinks about how the *student* will encounter the artefact. The *teacher* will consider different ways of teaching with the artefact. Thus, the teacher's critical engagement with the identification of an artefact is a vital element of professional agency.

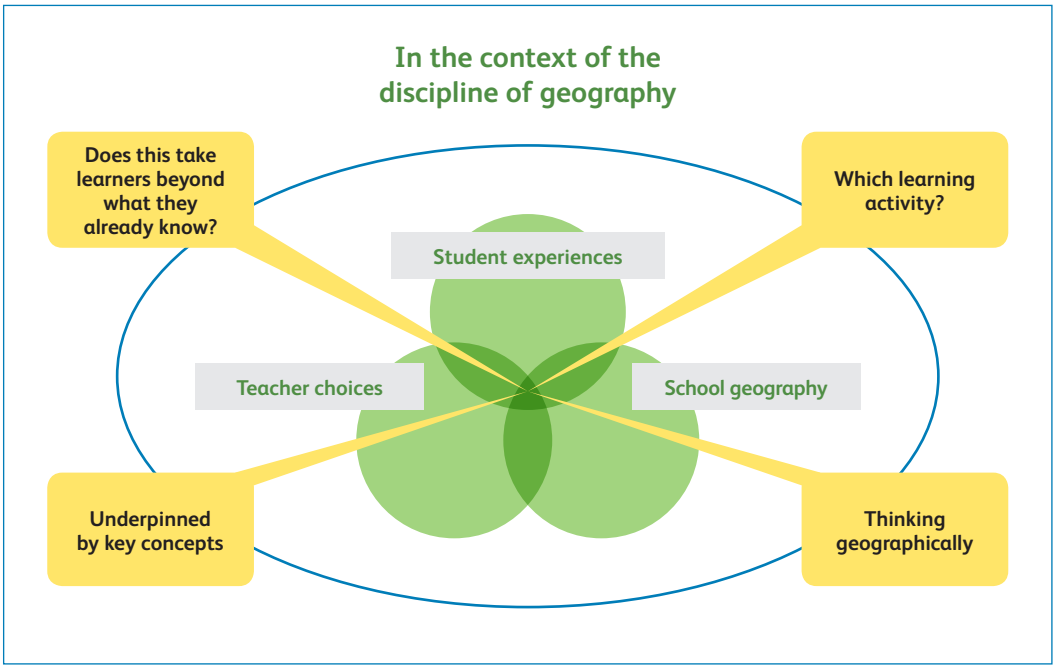


Figure 5: The GeoCapabilities version of curriculum making in geography, adapted from the GA's model (GA, 2014) and Kinder and Lambert (2011).

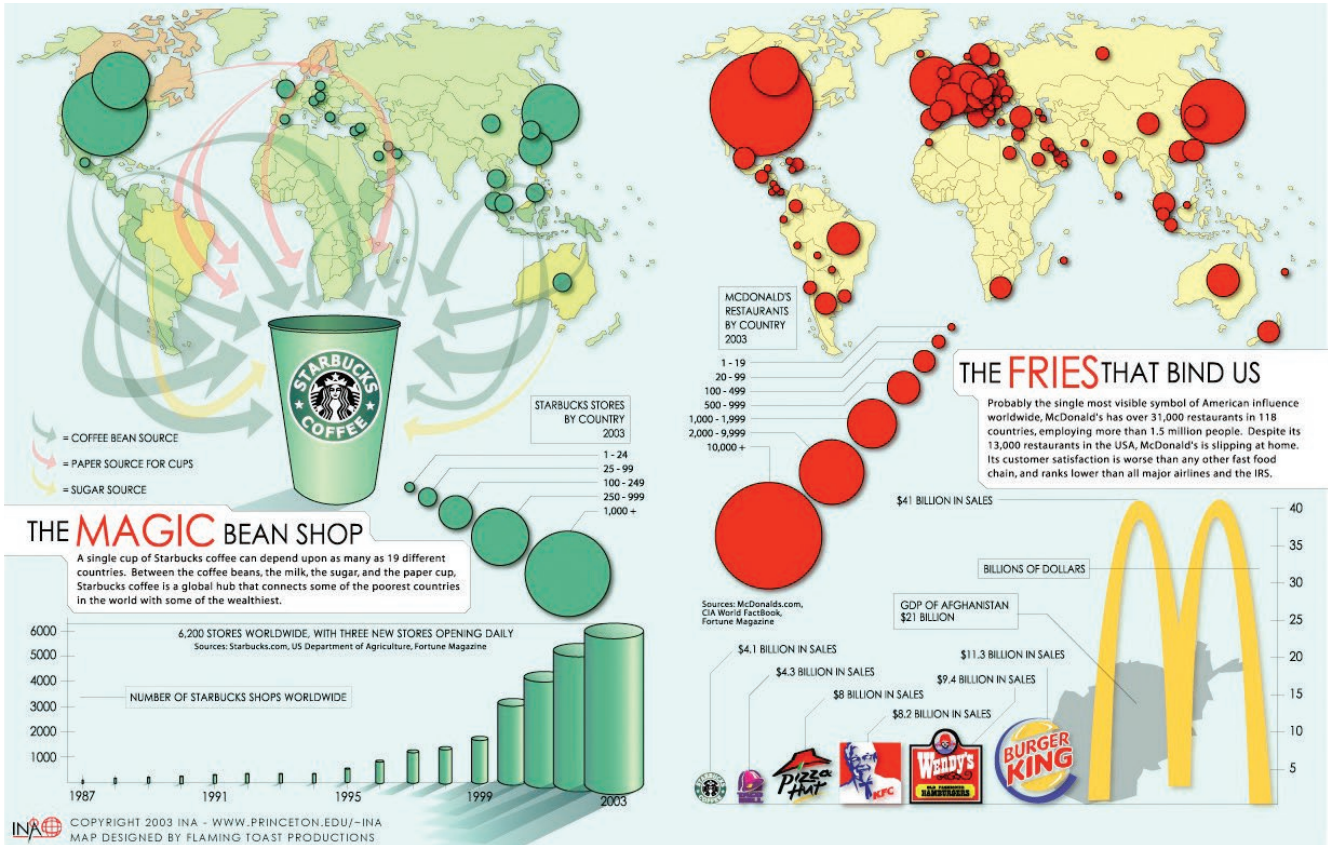


Figure 6: T he global presence of two transnational corporations in 2003. The teacher using this artefact shared some geographical content (Figure 7) which was linked to it. © Princeton University.

How to identify curriculum artefacts

Curriculum artefacts are highly likely to be already present within your teaching. In my Masters research I worked with a group of geography teachers to try and identify artefacts in their existing teaching. The aim was to understand the process of identifying what makes a resource an artefact. Once the purpose of an artefact is clear and the evaluation criteria have been applied and reflected upon, I believe artefacts become professional tools. Artefacts can be used in isolation but are likely to be used as the 'pivotal hook' amongst other resources. The main curriculum artefacts identified and shared by the teachers took two forms: infographics and video clips (Figure 6). Both of these types of resources are readily available and provide easy access to content for students, so are thought of as strong curriculum artefacts. Consequently, the evaluation of their purpose and value was insightful.

The infographic had been used as a starter activity but the teacher went on to develop its use reflecting on the geography contained within it, the learning activity and the students' experiences. Initially the teacher felt this style of planning was more time-consuming. However, during the lesson it resulted in the students being challenged to interrogate the information more carefully and in a way that was similar to an enquiry approach (Roberts, 2010). It also gave greater strength to the importance of taking time to share viewpoints. Combining these thoughts with the series of evaluation questions allowed this artefact to be fully deliberated. One outcome of this is that in planning their geography curriculum all teachers could reflect more on how resources could be used as artefacts to stimulate strong geographical learning.

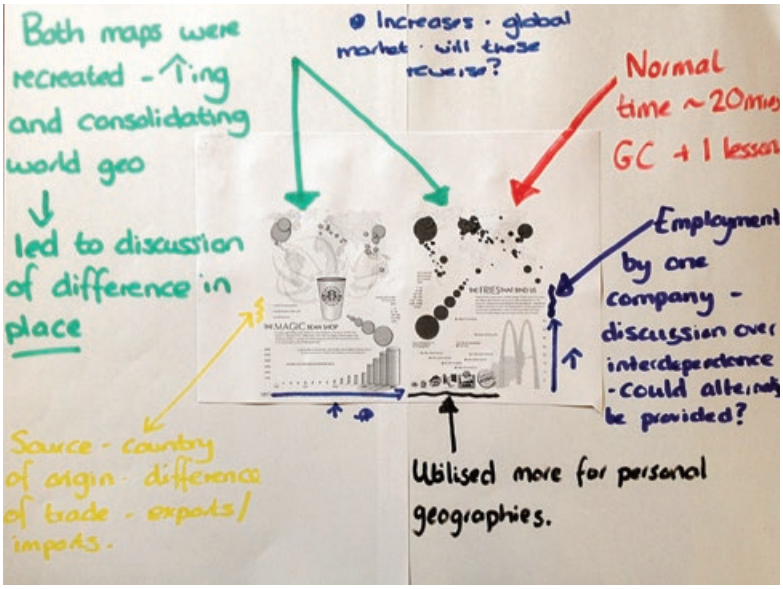


Figure 7: Notes on use of curriculum artefact shown in Figure 6.

Evaluating curriculum artefacts

To be a successful curriculum makeryou must undertake continuous individual evaluation. This is a rigorous process and can rapidly become demoralising without an effective framework. Module 2 of the GeoCapabilities programme (2016) presents a list of evaluative questions (Figure 8) that encourage teachers to evaluate curriculum artefacts before they are used in the classroom, as a fundamental part of the curriculum-making process. The teachers I worked with used these evaluative questions with the curriculum artefacts they identified.

As you create and/or evaluate your curriculum artefact, consider the following evaluative questions

Subject

- Which specific place(s) are studied?
- Where is the contextual geographical 'core knowledge'?
- Where is the powerful geographical knowledge?
- What are the ways in which geographical thinking deepens or extends understanding of the theme, issue or place?

Students

- In what ways are the students' prior experience/knowledge accessed and taken into account?
- In what ways are the theme, issue or place made accessible to the students?
- In what ways are students challenged to think beyond their current (or 'everyday') understandings?
- Is it possible to say how students' learning progresses?
- How does this theme, issue or place study contribute to the wider curriculum aims (in the UK, the 'big picture')?

Teacher

- What has the teacher done to generate a 'need to know', enthusiasm or motivation?
- In what ways has the teacher supplied data for students to assimilate, process, transform and communicate?
- How is the content sequenced – and how is this justified?
- How does the teacher lead the learning (including exposition), and how is this balanced by more 'pupil-centred' learning activity?

Figure 8: GeoCapabilities evaluative questions. **Source:** GeoCapabilities, 2016.

The teacher's relationship to the curriculum artefact is key to its success, for within curriculum making the students cannot engage with the geography without the teacher's guidance. The teacher's relationship with an artefact is to provide powerful geographical knowledge which is inaccessible outside of the classroom. Providing a structure with which to investigate a resource makes it an artefact for students to learn independence in thinking geographically. The teacher's choices and actions are just as important as the students' experiences and the geographical 'facts'. If a teacher deliberates about the artefact to draw out the geographical significance (perhaps even gaining new geographical insights) and then thinks through the purpose of associated lessons, then a curriculum is made. However, this raises the question of how to share artefacts. Unlike the creation of a resource, which can be photocopied and passed to colleagues, the deliberation that takes place about the use of an artefact is harder to share. The evaluation questions must be used so that the power of the artefact is not diminished.

Conclusions

By exploring the process of using curriculum artefacts and of evaluating their use by students, teachers are being curriculum makers. This is not a simple task and requires deliberation. Engaging in this professional activity can enhance the value of the geography lessons. It also ensures that teachers are reflecting upon the content and its significance alongside their students' needs. This is a key aspect of the GeoCapabilities approach. Curriculum artefacts can be identified from existing resources: by diligently applying the evaluative questions the learning value of an existing resource can be significantly developed. This approach to teaching and the use of resources can develop students' geographical knowledge and thinking which in turn, enhances their geographical capabilities.

Online resources
You can download the GeoCapabilities framework, additional information about curriculum artefacts and a list of further reading. Go to *www.geography.org.uk/tg* and click Spring 2017.

Dr Richard Bustin is Head of Geography at the City of London Freemen's School and a member of the *Teaching Geography* Editorial Board.

Email: *rbustin@gmail.com*

Kelly Butler is Head of Geography at Stafford Grammar School.

Email: *k.butler@staffordgrammar.co.uk*

Duncan Hawley is Chair of the GA's Physical Geography Special Interest Group and a Consultant to the GA. He co-ordinated the GA's involvement in the GeoCapabilities project.

Email: *duncan.hawley.geography@gmail.com*

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Geography against *learning*?

Aidan Hesslewood

Aidan makes a plea for teachers to assume a more powerful role in their students' geographical learning.

Figure 1: The differences between learning and education are the decisions made by a teacher **Photo:** © Barking Photographic.

The title of this article might seem to go against the educational norm, but it really isn't against learning itself. Rather, I hope to highlight the problem of what Gert Biesta (2012) has termed 'learnification', which I suggest in this article is a feature of late neo-liberalism. In doing so I want to make three broad points.

- First, that a sole focus on students' learning devalues our roles as teachers and professionals.
- Second, that we should simplify our aim as geography teachers to helping students 'become better geographers'.
- And third, teaching a *politically-engaged* geography is well-placed to educate young people to actively critique the deleterious effects of neo-liberalism (precarious employment, social inequality, and environmental injustice – see Figure 1) that will increasingly affect them in the future (Dorling, 2013).

- Advancement of free trade and the unrestricted movement of capital
- Privatisation of common assets (e.g. healthcare, education, transport infrastructure)
- Positioning of individualism and competitiveness as incontestable virtues
- Decreasing of social protections and welfare
- Redistribution of wealth to corporate elites through an 'accumulation by dispossession'
- Promotion of the rule of 'experts' and technocratic knowledge-elites; the use of 'data' to justify decisions

Figure 1: Key aspects of neo-liberalism (adapted from Springer, 2010).

Learnification

'Learnification', as described by Biesta (*op. cit.*), is the shift towards an entirely student-centred concept of learning due to the misrepresentation of 'education' as a system of knowledge transmission. At the current juncture, learning is conceptualised as individualistic and devoid of content and purpose. The focus is often on 'learning to learn', 'building learning power' (e.g. Claxton, 2012), and 'learning dispositions', often at the expense of subject knowledge. Coupled with the extreme idea that in this day and age of high technology, knowledge might now be 'obsolete' (Mitra, 2013), the teacher has been sidelined as a 'facilitator of learning', rather than being central to the educational process. The position of teachers has been further marginalised as education becomes ever more neo-liberalised and 'learners' are posited as consumers in charge of their own education. Indeed, human learning happens all the time, but the point here is that not all learning is *educational* (Osberg and Biesta, 2008).

According to Biesta (*op. cit.*), the difference between education and learning is profound. Education doesn't just mean that students learn, but that they learn *something*, for particular *purposes*, and from *someone*. This is not to deny that students construct knowledge for themselves, but to acknowledge that it is the teacher who actively steers students in this knowledge construction process, confronting them with ideas outside their everyday experience (e.g. tectonics, underdevelopment, tropical ecosystems), or situating their personal geographies within a wider disciplinary framework (e.g. experience of the seaside becomes contextualised through geomorphology, economic development, or environmental management). Education *is not* about meeting the needs of the 'learner'.

A teacher must:

- be aware of pupils' capabilities and their prior knowledge, and plan teaching to build on these
- contribute to the design and provision of an engaging curriculum within the relevant subject area(s)
- know when and how to differentiate appropriately, using approaches which enable pupils to be taught effectively
- have a secure understanding of how a range of factors can inhibit pupils' ability to learn, and how best to overcome these
- demonstrate an awareness of the physical, social and intellectual development of children, and know how to adapt teaching to support pupils' education at different stages of development
- take responsibility for improving teaching through appropriate professional development, responding to advice and feedback from colleagues.

Figure 2: Extract from Teachers' Standards that exemplify the teacher's role in making decisions and exercising professional judgement. **Source:** DfE, 2011.

Learners cannot be consumers because they are not in a position to know what their needs are. Teachers, however, *are* in a position to identify these needs, and exercise their professional judgements to do so (Figure 2).

There is, of course, a danger that these sorts of arguments about 'learnification' are taken too far the other way. The idea that children need 'grit' to cope with the demands of boring rote lessons – so that they can access better jobs in the future – is a beast whose head is beginning to rear ever more frequently (Gill, 2014). I'm advocating, here, the need for some middle ground. We do need a re-emphasis on the value of knowledge, both factual and conceptual, but we also need 'powerful pedagogies' in geography teaching (Lambert *et al*., 2015).

Learnification and geography

Despite the so-called 'knowledge turn' and the removal of National Curriculum levels in September 2014, there is a danger that schools continue to emphasise 'learning skills' and downplay subject knowledge. Furthermore, assessment in many schools remains technocratic and devolved from the educational process, and schools' obsessions with Ofsted, examination results and league tables means that the increasing use of metrics to measure 'learning' (and its twin 'progress') will be stubborn to shift. The measurement of learning/progress is often conceptualised as a straightforward affair that can be conducted quantitatively within and between lessons, and is often judged by school leaders who have no specialist geographical knowledge or experience of thinking geographically.

The implication here is that 'learnification' and the pressure of ticking boxes in lesson observations can lead to teachers trying to show that the students in front of them are great 'learners' rather than great geographers. Margaret Roberts suggests that 'regardless of what is demanded by the [teaching] standards I do not think a geography lesson is good unless it includes geographical data, geographical ideas and a locational context' (Roberts, 2011). Indeed, by focusing on 'learning' and the need to 'show progress', the risk of letting a solid geographical understanding slip becomes ever more likely.

The potential result of this learnification in school geography is an increasing number of students who lack a deep geographical knowledge and the capacity to think geographically. Of course, poor geography teaching also does this (Ofsted, 2011). I suggest that we would be much better off junking the learning jargon (e.g. 'securing progress') and reducing our purpose as geography teachers to a much simpler statement: to help our students *become better geographers*. If we do this, a number of things become clear. Being a geography teacher means making decisions about the students in front of us: inspiring them; helping them to navigate increasingly complex geographical terrains; helping them construct a knowledge and understanding of places and environments outside their everyday experience, while recognizing the relevance of their own personal geographies (Roberts, 2014); helping them understand how places are interconnected and how they change; and helping them develop the communication and enquiry skills they need to articulate their knowledge.

A geographical education 'against learning'

And what really makes better student geographers are 'powerful pedagogies' (Lambert *et al*., 2015, p. 8; Roberts, 2014) – well-planned, resourceful and inspiring lessons that engage young people with the world around us, not systems that obscure and reduce the complex learning process to jargon, meaningless numbers, and pointless traffic-light tasks. We need to de-commodify assessment and think about the real *value* of the geographical knowledges – both factual and conceptual – that *emerge* (Osberg and Biesta, *op. cit*.) in and through our lessons.

And this raises questions about the purpose of a geographical education. How will it contribute to a greater understanding of the processes that shape our students' geographies and life chances in the future? What about the networks of global production that influence the shifting of local economies and labour markets; the political-economic relationships that continue to ensure the belching out of millions of tonnes of carbon, or keep us reliant on finite fuels and resources; the government policies, economic practices and cultural politics that produce trenchant social inequalities, environmental injustices, and uneven development; and the physical processes that affect the way humans encounter risk in different parts of the world (Hall *et al*., 2015; Klein, 2014)?

Furthermore, for geography students to really become analytically critical about this future neo-liberalised world, we teachers should shift our attention away from the fads, metrics and fashions produced by 'learnification', because the discourse of learning goes like this: by developing skills to learn/personal learning skills/learning power etc., young people are able to cope with (even take advantage of) precariousness and uncertainty in the future. But it is precisely this view that should be unravelled! Young people shouldn't just have to cope and fit in, but have the knowledge and capabilities to critique, challenge, overthrow and change.

'Learning' can't help do this, but *thinking geographically* can, and in this way a geographical education becomes an inherently politicised practice, especially if we also acknowledge *the political* production of geographical knowledge in academia (Roberts, 2014). Feminism, Marxism, post-structuralism, post-colonialism, humanism, performativity, queer geographies, and the multifarious political conditions (class, gender, age, sexuality, race, ethnicity) that intersect and frame the production of knowledge gives geographical thinking that bit more power. Surely, then, we are not just asking what it means to 'learn geography'? A more powerful question is *what does it mean to be geographically educated?*

Conclusions

This question has significant implications for both geography teachers and geography teacher educators. First, the rising neo-liberal tide is increasingly eroding teaching as a profession. Teacher education, for instance, is effectively becoming privatised through academisation and school-based training programmes, which means that student geography teachers in the future may find themselves in programmes with no specialist geography pedagogy taking place (Geographical Association, 2015). Local school-based training partnerships should work closely with subject organisations like the GA and its consultants and branches to ensure the quality and sustainability of the supply of geography teachers in the future.

Second, geography teachers need to emphasise the importance and *purpose* of geography to their students, not just as a discipline which helps provide solutions to global problems, but as 'one of humanity's big ideas' (Bonnett, 2012). In other words, students need a clearer idea of what geography is, and how to *become better geographers*, not just how to move from one 'level of progress' to another, however articulated. The frustrating irony is that removing levels in 2014 has created lots of hot air and new labels that are just as useless and confusing as the old. The centrality of *geographical thinking* in assessment is paramount, yet seems to be utterly lost in most of the assessment systems acclaimed in the education press. This is because decisions about assessment (and therefore 'tracking progress') are often made in the interests of senior leaders under the constant threat of inspection, to enable the collection of more and more data (of course, under neo-liberalism data 'can't lie').

Geography teachers should exercise their power as professionals to argue against these trajectories. We should, after all, be creating a powerful geography education for our students.

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Aidan Hesslewood is a geography teacher at Bourne Grammar School.

Email: *aidan.hesslewood@bourne-grammar.lincs.sch.uk*

Martin Evans

Erosion, restoration and carbon cycling in UK peatlands

Martin describes the dramatic changes that have occurred in UK peatlands, explores the impact of these changes on the carbon cycle, and suggests ways in which work on peatlands might support skills and fieldwork elements of the 2016 A level curriculum.

Accompanying online materials

The study of water and carbon cycling is part of the common core of the 2016 A level specifications. While the study of hydrology and the water cycle is deeply entrenched in school geography, the carbon cycle elements of this core are perhaps less familiar. Study of the global carbon cycle requires understanding of key processes controlling movement of carbon between the major carbon stores, including the oceans, ocean sediments, the atmosphere, soils and the terrestrial biosphere (IPCC, 2013). Although the oceans are the largest carbon stores and so vital to a global understanding, aspects of the terrestrial carbon cycle lend themselves better to local study and fieldwork and are good ways for students to understand human interactions with the carbon cycle.

Land use, land use change, and forestry (often referred to as LULUCF) are recognised in United Nations carbon accounting as potential mechanisms for mitigating climate change. Changes in land use or forestry practice have the potential to change rates of carbon sequestration into soils or forest timber. If carefully managed these changes can be positive and – if suitably verified – can be included in reporting against international carbon targets. In the UK one of the largest stores of terrestrial carbon is organic matter in soil, and the peatlands (highly organic soils) contain over half of total soil carbon. Most of this is stored in the blanket peatlands of Scotland and upland areas of England and Wales. Blanket peats represent 91% of UK peatlands by area, with fenland peat (3%) and lowland raised bog (6%) making up the rest. Fen and raised bog were formerly much more extensive, but have been either exploited for agriculture or mined to provide horticultural peat.

UK peatlands are also places where there has been extensive land cover modification through human action, and so make an interesting case study of the ways in which human activity impacts on the terrestrial carbon cycle. Most schools in the UK are within two hours' drive of a peatland, and many are much closer than that; so these sites are familiar to students and may provide fieldwork opportunities. This article describes some of the dramatic changes which have occurred in UK peatlands over the last 500 years and explores the impact these changes have had on carbon storage and carbon cycling. It also introduces ways in which work on peatlands might be used to support skills and fieldwork elements of the new A level curriculum (see the accompanying online materials on A level fieldwork and teaching data skills through the water and carbon cycle).

UK peatlands

Peat soils store carbon because the rate of fixation of carbon from the atmosphere by photosynthesis in peatland plants exceeds the rate of loss of carbon from the system through decomposition of plant litter and organic matter in the peat and through plant respiration. In mineral soil systems microbial decomposition of litter is typically in equilibrium with the supply of new organic matter as litter. However, in peatland systems high water tables, leading to low oxygen availability, together with cold and acidic conditions, mean that microbial decomposition is reduced. Consequently the soil builds up a very thick organic layer composed of partially decomposed litter: this is peat.
In addition to losses of gaseous carbon from microbial decomposition and plant respiration, peatlands may also lose carbon through dissolved carbon losses in drainage waters or through loss of particulate carbon as plant matter or eroded soil are transported in peatland river systems.
A typical carbon balance for an upland peatland in the UK is illustrated in Figure 1.

Healthy peatlands accumulate carbon year on year, so over the lifespan of a peatland system large stocks of carbon accumulate at the land surface. Some peatlands in the wettest parts of the UK have been accumulating carbon for most of the Holocene, but most peatlands began to form after about 7000 BP, a period of wetter climate.

Process	Flux (gC m^{-2} yr^{-1})
Net Ecosystem Exchange (NEE) (the balance of photosynthesis against decomposition and plant respiration)	-71
Loss of dissolved organic carbon (DOC) in streams	+26.1
Loss of dissolved CO_2 in streamwater	+1.1
Loss of methane through microbial action	+2.2
Loss of particulate organic carbon (POC) (solid organic soil and plant material) in streams	+2.5
Net carbon balance	**-39.1**

Figure 1: Typical carbon balance for relatively intact UK peatland (figures taken from Billett *et al.*, 2010). Note that by convention negative values are flows of carbon out of the atmosphere (carbon sequestration) and positive values represent carbon loss from the peatland. Note also the units, which are gC m^{-2} yr^{-1}, or grams of carbon per metre squared per year.

Human impact through Neolithic forest clearance has also been implicated in the growth of peat cover (see Charman, 2002 for a good discussion of peat initiation). Typical peat depths range from 1–4 metres, so across the UK the total carbon stored in peatland soils is significant. Soils contain around 95 % of the stock of land carbon (the remainder is in live vegetation, mostly trees). Just over half of all UK soil carbon (circa 5.1 billion tonnes) is stored in peatlands, and up to 90 % of this is in Scotland (Ostle *et al*., 2009).

Peat erosion and carbon cycling

Peatlands in the UK and Ireland are globally distinctive in terms of the degree of peat erosion which they have suffered in the last millennium. Across the UK and Ireland 20–30 % of upland peatlands are impacted by severe gully erosion (Figure 2) (Evans and Warburton, 2007), and in the worst eroded areas extensive bare peat is exposed at the surface (Figure 3). The causes of peat erosion are multiple. Climate change (Little Ice Age storminess and desiccation in the Medieval Climatic Optimum), and multiple human impacts including industrial pollution, overgrazing, and fire have all been implicated as causes of extensive erosion across the uplands. In particular locations a specific cause for local erosion can sometimes be identified, but across the UK and Ireland as a whole it is the coincidence in time and space of a series of natural and anthropogenic factors that have stressed peatland surfaces and enhanced erosive potential: this explains the particularly severe peatland degradation of this region.

Erosion leads to carbon loss from peatlands via three mechanisms:

1. directly, through erosion of peat particles (increasing POC losses)
2. indirectly, through reduction in carbon fixation by peatland vegetation where there is extensive bare peat (decreased Net Ecosystem Exchange)
3. through peat drainage due to gully erosion. This lowers water tables near gullies, which in turn increases rates of organic matter decomposition in the upper layers of the peat and leads to greater dissolved organic carbon losses (Evans and Lindsay, 2010).

In the most eroded peatlands the POC losses alone can be in the order of 70gC m^{-2} a^{-1} (Billett *et al*., 2010) a magnitude of carbon removal which can shift peatlands from being sites of carbon sequestration to sites of net carbon loss. Note that if POC losses in Figure 1 were on this scale the site would show a net carbon loss.

Peatland drainage and carbon cycling

Over 50 % of the UK's 29,000km^2 of peatland has been impacted by drainage (Milne and Brown, 1997). Drainage, supported by agricultural subsidies with the aim of improving grazing and grouse habitat, was commonplace from the 1950s to the 1990s. Drains are typically closely spaced (10–20m) and circa 50cm deep, and lead to local reductions in water table, both through direct drainage and by channelling overland flow away from downslope areas. Lowered water tables increase the depth of the oxygenated layer near the peat surface and are commonly associated with increases in CO_2 flux from peatlands to the atmosphere (Bain *et al*., 2011). Increased decomposition of organic matter also leads to greater losses of dissolved organic carbon (DOC) in runoff from drained systems (Worrall *et al*., 2007). Consequently peatland degradation through drainage also has a negative effect on peatland carbon balances, leading to reduced carbon sequestration.

Figure 2: Severe gully erosion on the southern slopes of the Bleaklow Plateau, Derbyshire. **Photo:** © Martin Evans.

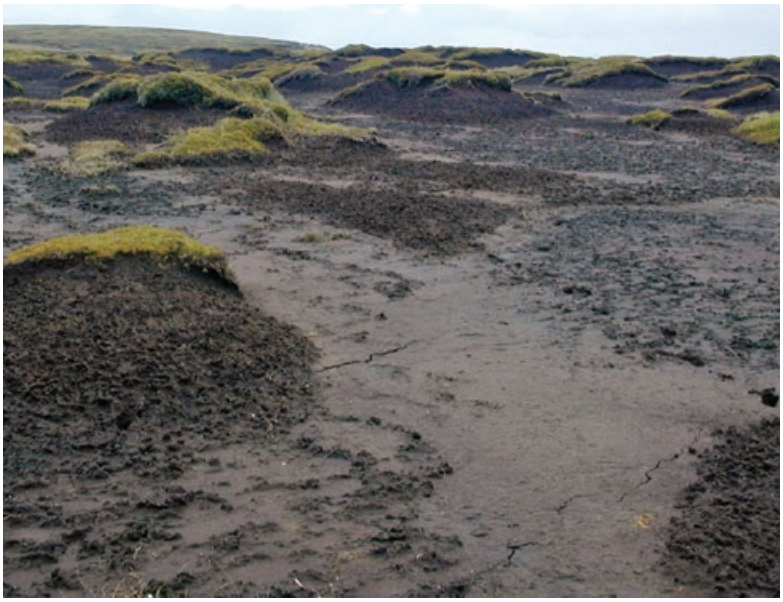

Figure 3: Extensive bare peat exposed in eroded upland peat. **Photo:** © Martin Evans.

Peat restoration and carbon cycling

The unique and severe nature of peat erosion across the UK has led to a long history of efforts to restore these degraded systems. The UK is a world leader in developing approaches to peatland restoration. Restoration efforts have typically aimed to restore natural vegetation to peatland surfaces and/or to raise water tables (Figure 4).

Figure 4: Severe peat erosion on the Kinder Scout plateau, Peak District National Park. In the top right-hand corner of the image the effect of re-vegetation through aerial seeding is clearly visible. **Photo:** © Moors for the Future.

One of the most intensive areas of ongoing restoration is the upland peatlands of the southern Pennines, which are among the most degraded peatlands in the world. Here peatland drainage is driven not by drains but by deep erosional gullies which have been blocked by stone dams (Figure 5). In addition to gullying, peat erosion has created large areas of bare peat with no vegetation cover. Restoration approaches have therefore included industrial-scale seeding of the landscape to restore vegetation cover. Aerial applications of lime, seed and fertilizer create conditions where a nurse crop of utility grass is established (Figure 6). This is not the natural vegetation cover but acts to stabilize the surface so that desirable species such as cottongrass, heather and sphagnum moss can establish. Propagation of heather is encouraged through the application of cut heather mulch, which also aids grass seed germination. Cottongrass plugs are planted in some areas and sphagnum propagules are sprayed onto the surface to encourage sphagnum regrowth. This approach leads to rapid establishment of vegetation cover. As sites are re-vegetated primary productivity is restored. Rather than bare peat, surfaces are covered with vegetation which actively fixes carbon from the atmosphere and adds fresh litter to the peatland surface.

The re-vegetated surfaces are much less prone to erosion, so losses of particulate carbon from the peatland are reduced by an order of magnitude. Re-vegetation therefore has the potential to significantly reduce and/or reverse carbon losses from eroded systems.

Intact peatlands have water tables which are close to the surface for most of the time. Peatland drainage lowers water tables and increases the depth of oxygenated peat, favouring microbes which decompose peat and plant litter. Lower water tables are therefore associated with higher losses of gaseous and dissolved carbon from the peat. In the last two decades blocking of these peatland drains using heather bales or peat blocks to raise water tables has been widely undertaken as part of peatland restoration work.

In the northern Pennines alone 1600km of moorland drains have been restored (Figure 7). In Scotland large areas of peatland which were drained for forestry have been restored through drain blocking and the removal of trees from bog surfaces. Drain blocking is effective in raising peatland water tables, although it may not effect complete hydrological restoration of the peatland (Holden *et al*., 2011). Higher water tables imply reduced CO_2 losses but the impact on dissolved carbon loss is less clear. On average across the UK, the evidence points to reduced DOC flux from drain-blocked sites but there are many sites where the impact is limited or not detectable (Armstrong *et al*., 2010).

Figure 5: Gullies blocked by stone dams. These stabilise the gully floors, promoting re-vegetation and helping to raise water tables. **Photo:** © Moors for the Future.

Figure 6: Aerial seeding of bare peat in the southern Pennines. **Photo:** © Moors for the Future.

Modelling studies can assess the combined impact of peatland restoration on carbon balance. Work by Worrall *et al.* (2009) assessed the impact of the application of best practice restoration approaches across all of the severely eroded peatlands of the Peak District National Park. The model estimated that overall the peatlands area is at present a net sink of carbon, but that 20% of the area is a carbon source. Maximising restoration across these peatlands could produce a 2.5-fold increase in the size of the carbon sink and mean that no area of the peatlands was a net source of carbon to the atmosphere. The most effective component of restoration in these scenarios was the re-vegetation of bare peat.

Conclusions

Peatlands are sometimes characterised as 'the UK's rainforests' because of the critical role they play in its terrestrial carbon cycle. Human action has significantly reduced the carbon sequestration potential of UK peatlands, but more recently landscape-scale efforts at peatland restoration have begun to reverse this trend. These familiar landscapes, particularly English peatlands, have suffered in part because they are in easy reach of many major urban centres. Where peatland restoration has been undertaken these landscapes now provide local examples of human modification of the terrestrial carbon cycle which can explain and exemplify carbon cycling topics within the new A-level specifications.

Figure 7: Moorland drains are widespread across upland Britain. In this image of peatland restoration in the northern Pennines the drain has been blocked, leaving a series of small pools. **Photo:** © North Pennines AONB Partnership.

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Useful web resources

To see time lapse imagery of peatland re-vegetation over a 13 year period, visit *www.youtube.com/watch?v=Wl_HGksxqFo*

Read more about peatland restoration here: *www.moorsforthefuture.org.uk/moorlife* and here *www.northpennines.org.uk/Pages/Restoration.aspx*

The IUCN peatlands report (*www.iucn-uk-peatlandprogramme.org/publications/commission-inquiry/inquiry-findings*) is a useful introduction.

Martin Evans is Professor of Geomorphology at The University of Manchester.

Email: *martin.g.evans@manchester.ac.uk*

Duncan Hawley and John Lyon

Plate update: refreshing ideas for teaching plate tectonics

To help ensure that your teaching on plate tectonics reflects the latest understanding, this article outlines some recent developments and provides a subject knowledge 'refresher'.

Accompanying online materials

Introduction

Somewhere in your curriculum you will teach about plate tectonics. Whatever your sources, it may be easy to think you are teaching ideas that reflect current understanding of the way the Earth works. But beware – our experience indicates that this is often not the case. We have found that some aspects of teaching about plate tectonics are based on sources of information and teachers' own knowledge that is often well out-of-date and over-simplified (albeit telling a 'neat' story), and in some cases just plain inaccurate. Similar concerns have been raised by Trend (2008), Dove (2016) and research into science teaching by King (2012).

This article provides a 'refresher' that updates subject knowledge about some key recent developments in understanding how plate tectonics works and which consequently offer improved explanations for the distribution and characteristics of earthquakes, volcanoes and some surface landforms. It is intended to help teachers decide if and how they should adjust what they presently teach to reflect current understanding about the way plate tectonics operates, thereby developing students' critical sense of the plate tectonic 'story' encountered in textbooks, on diagrams, in the news, via the internet and in other media. Not every aspect of the topic can be covered in this short article, but some relevant further sources of information are recommended.

Crust and lithosphere

The outermost layer of the Earth is commonly described as being split into 'crustal plates', but this idea is inaccurate and conceptually misleading. Plates are a function of the mechanical (physical) properties of the Earth's cold outer shell, the strong, rigid (but still flexible) and mostly brittle layer, termed the **lithosphere**. This extends for some depth below the crust, hence the correct term is '**lithospheric plates**' or '**tectonic plates**'. The lingering use of the 'crustal' misnomer is a case of historical inertia; the concept of the crust was established long before the discovery of the lithosphere and plates (and probably endures in the popular imagination as a hard thin casing, as on a pie). However, the Earth's composition is, in scientific terms, less intuitive. Its outer layering exists in two ways: by chemical composition (crust, mantle) and by mechanical properties (lithosphere, asthenosphere). The lithosphere is a coupling of crust and uppermost mantle due to cooling; its thickness varies, but its lower boundary is considered to be where the mechanical properties change from elastic to plastic behaviour (around the 1300°C isotherm) (Figure 1). Rigidity allows it to bend (elastically) when subjected to a load, which helps explain the structure of ocean trenches and the deep waters around oceanic volcanoes. The lithosphere (i.e. plates) under oceans is 50–100km thick (thickest under older ocean basins) including a 5–8km veneer of basaltic crust, and is relatively warm and dense.

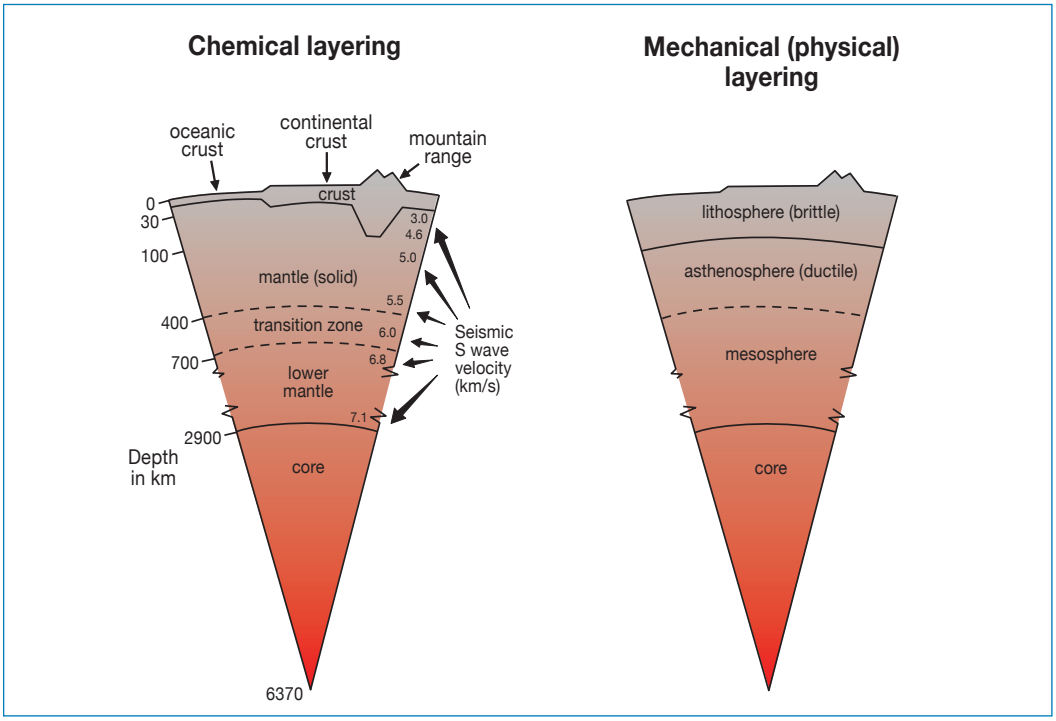

Figure 1: Two ways of dividing the Earth's outer layers. Plates function as mechanically coherent portions of the Earth so are formed from lithosphere which extends below the crust. **Source:** Trinity College Dublin (n.d.).

The lithosphere under continents is up to 300km thick, with a 30–40km crust of granitic rock (and sedimentary derivatives) that is relatively cool and buoyant. Plates can comprise portions of both oceanic lithosphere and continental lithosphere, although these are never vertically juxtaposed. Where one type passes laterally into the other is termed a **passive margin**; these are not seismically active but represent the site of former tectonic rifts, e.g. the Atlantic seaboards of South America and Africa.

The mechanics of material in the mantle

Some sources describe the mantle as 'semi-solid' or 'semi-liquid'. To many people 'semi-' implies around half, but in fact the mantle is almost entirely (99.9%) solid. We know this because the mantle will transmit seismic S (shear or shake) waves that can only pass through solid material. In the upper mantle is a zone called the **asthenosphere**, identified by low seismic S wave velocities. Here the rocks are ductile, so will not fracture; but they flow and deform plastically, a process known as viscoelasticity, when subjected to stress over long periods. Glacial ice exhibits a similar behaviour, as although solid it will deform and flow slowly downhill over time. Silly Putty® is another material exhibiting plastic, elastic and brittle behaviours similar to the mantle, with each state dependent on the timescale and force of stress applied.
The lower part of the mantle (mesosphere) is subject to greater pressure so although it can deform and flow, the material here is significantly more viscous. In 2015 geoscientists 'discovered' a distinct 10km-thick low viscosity layer containing about 2% of melted material at the lithosphere/asthenosphere boundary under oceanic lithosphere. This 'slippery' rock is thought to provide clear evidence that plates slide and glide over the asthenosphere below, rather than that they are moved by a convective mantle coupling to the bottom of a plate (Stern *et al*., 2015).

Top down tectonics

What exactly makes tectonic plates move is still being explored by geoscientists. However, the 'neat' classic model of giant convection cells rising up in the mantle with the tectonic plates just 'surfing' on the top, as frequently illustrated by the 'pan of water' or 'conveyor belt' analogies, is now an outdated paradigm. Seismic **tomography** (a 'CAT scan' of the Earth produced by image-processing the pathways and differential velocities of seismic waves as they propagate through the Earth) has not been able to identify convection cells in the mantle that are large enough to drive plate movement. Convection does take place, but heat is dissipated as patchy thermal **plumes** rather than a pattern of strong, regular cells. These help explain previously anomalous 'hot spots' such as Hawaii. A plume is also thought to be responsible for the volcanism of Iceland. Plumes are considered to originate at the mantle-core boundary: about ten major plumes are thought to exist (Courtillot *et al*., 2003).

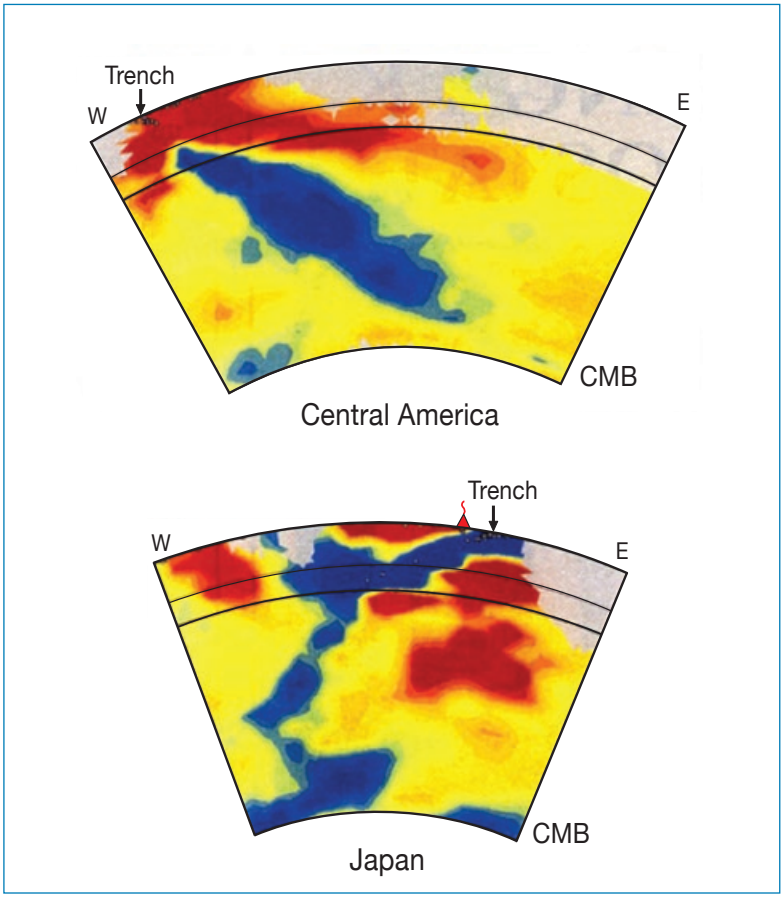

Figure 2: Tomographic slices through the lithosphere and mantle. Blue colours represent cold slabs of lithospheric plate descending to the core mantle boundary. **Source:** Based on the work of Van der Hilst *et al*., 1997 and Fukayo *et al*., 2001.

Tomography has revealed cold, dense slabs of plate material sinking deep into the mantle at **convergent margins**, which pulls on the rest of the tectonic plate (Figure 2). This process is called **slab pull** and it is the subduction of relatively cold, dense slabs that is now considered to be the key active driving force of plate movement. The idea that magma injection pushed plates apart at **divergent margins** (which was allied to the giant convection model) is now regarded as unsound. The current model has slab pull extending and thinning plates at divergent margins, which reduces pressure on the underlying asthenosphere, causing it to partially melt. The resulting magma wells up under the divergent margin, cools and is added to the plate as new lithosphere. Much of the magma never reaches the surface but it is buoyant enough to push up the crust at divergent margins to form **ridge and rift** features, e.g. mid-ocean ridges. This elevation produces a slope away from a spreading ridge, allowing gravitational force to slide the lithosphere towards the subduction zone, in a process misleadingly known as **ridge push**. As plates spread away from the divergent margins they become increasingly older, colder, thicker and denser. The discovery of the 'slippery' layer at the base of plates helps explain why plates move under slab pull. When the lower portion of a descending slab detaches it sets up deformation in the upper mantle: this induces weak convection motions that suck overlying plates together, a process known as **slab suction**. So the current view reverses the large-scale convectional cell model of the force behind plate movement, which is now thought to be driven by top-down cooling and sinking of lithospheric slabs.

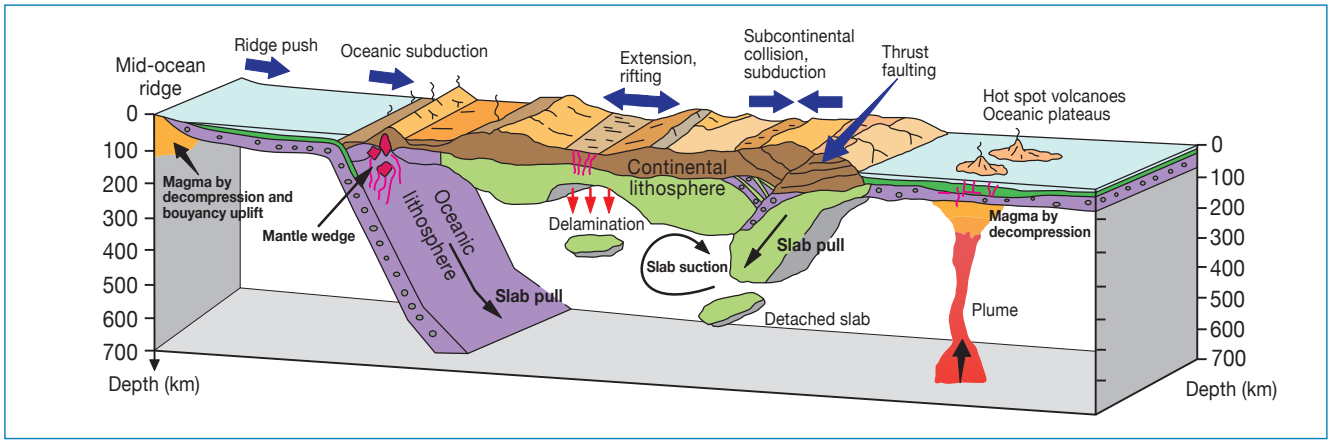

Figure 3: Summary illustration of lithosphere/plate processes and interaction with the mantle. Vertical and horizontal dimensions are not to scale. **Source:** adapted from an original sketch by Artemieva and Meissner, 2011.

Melting the mantle with water

Some sources attribute magma generation, and the formation of volcanoes along subduction zones, to the melting of the downgoing plate due to frictional heat created by pressure as it grinds against the overriding plate and mantle. Although this account is neat and intuitively convincing, it is erroneous and inaccurate for three reasons:

- slabs of lithosphere are relatively cold (which is why they can be picked out by tomography) so require considerable heating before reaching melting point
- as subducting slabs descend into the mantle and become hotter the frictional stresses diminish, so negligible heat is generated
- a frictional force would work against melting as pressure raises melting points, so any such pressure would lead to the plate or mantle remaining in a solid state at greater depth.

However, the **presence of water** in the rocks of a subducting plate results in **partial melting**, although the plate itself does not melt. Oceanic plates contain water locked up in the basaltic rock and overlying sediments, which is driven off by increasing temperature and pressure and acts to reduce the melting point of rocks in the mantle above the subduction plane, causing portions of the **mantle wedge** to melt. Some of the magma melt rises up through the mantle and overlying lithosphere to erupt at the surface, producing a linear belt of volcanoes. As the magma ascends it changes in chemical composition due to fractionation, with the magma becoming progressively less dense but more viscous as it rises to the surface. In addition, the water dissolved in magma acts as a volatile and expands rapidly (exsolves) when pressure is released, leading to the explosive volcanic eruptions associated with subduction zone volcanoes.

Mountain belts are more than folds

The 'classic' textbook model for the formation of mountains envisages a collision of continents causing sedimentary rocks to crumple into high peaks creating 'fold mountains' as the crust is shortened. However, compressed rocks do not only fold; they also fracture along low-angle fault lines causing massive slices of lithosphere to thrust over each other, stacking up to great height. The Alps were constructed by this process. Thrust faulting helps explain why earthquakes occur in 'interior' mountain regions like the Himalayas (e.g. in Nepal in 2015). Subduction plays a major role in mountain building by thickening continental lithosphere. At oceanic-continental subduction margins, partial melting creates magma that rises from the subduction wedge and intrudes into the lithosphere as massive granite plutons. A small fraction of magma can reach the surface to create volcanic mountains (e.g. the Andes) but most cools in the roots of mountains, and the added thickness provides more buoyancy to the lithosphere, uplifting the surface. Rapid erosion can counteract uplift but active plate tectonics always wins until subduction ceases. The great linear or arcuate mountain ranges of the world are formed by a combination of tectonic processes, so 'fold mountain' is a misnomer: it should be termed 'mountain belt' and closer attention should be paid to the tectonic position and geology to help identify what is likely to have caused its formation.

Duncan Hawley is Chair of the GA's Physical Geography Special Interest Group and is also a Consultant to the GA.

Email: *duncan.hawley.geography@gmail.com*

John Lyon retired as Programme Manager for the GA and is a member of the GA's Physical Geography Special Interest Group..

Email: *johnhlyon@gmail.com*

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Reviews

Reviews of new geography resources.

BOOKS

Activity pack

GCSE Edexcel B Dynamic Geography Activities: Topic 2: Development Dynamics
58 photocopiable A4 pages including 10 activities plus CD with PowerPoint presentation
GCSE Edexcel B Dynamic Geography Activities: Topic 4: UK's Physical Landscape
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Bristol: ZigZag Education, 2016
Pack price: £49.00 each

These resources are a welcome support to teachers delivering the new GCSE specifications. Each pack contains worksheets, self-assessment sheets and answers. There is also a CD with extra visual stimuli: limited in Topic 2, but better executed in Topic 4 (the whiteboard presentation is an essential upgrade to the printed worksheet photographs).

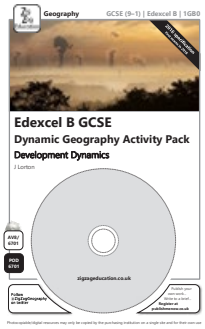
The activities are creative and thought-provoking and will allow students to explore the content of the unit while also practising their geographical skills. Teachers will need to add their own annotation exercises for Topic 4. Both packs' activities cover all specification points; Topic 4 also covers both optional sub-topics. There are teacher and student instructions and homework options too.

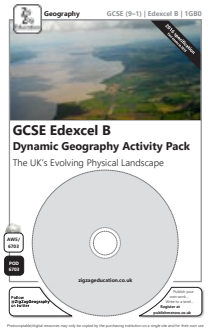
The activities offered show a healthy mix of visual, aural and kinaesthetic learning as well as a variety of individual, small-group and whole-class tasks. Differentiation supports lower ability students and provides welcome challenge for higher ability students. Topic 4 has the potential to integrate with initial teaching; the Topic 2 pack, requires more prior knowledge and might function with consolidation or revision work.

ZigZag have created similar activity packs to support teaching AQA, Edexcel A, OCR B, Eduqas A and WJEC specifications, with Keyword Activity Packs and Topic Test Packs available for further support and inspiration.

As teachers find their way with the new specifications, these resources could save planning and preparation time. They are neither authorised nor endorsed by the awarding bodies but, this accepted, they could be a welcome addition to departmental GCSE teaching and learning ideas banks.

Stephen Schwab, Consultant to the GA and Co-Chair of the GA's Secondary Phase Committee





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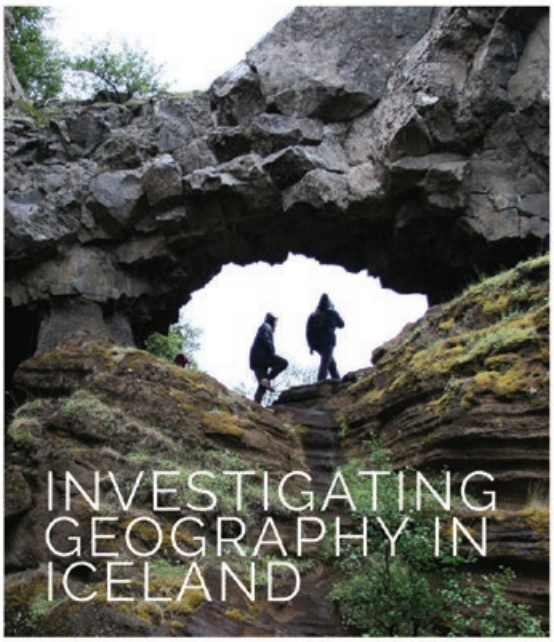

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